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HP 432A

JUN. 1972

OPERATING AND SERVICE MANUAL

11-2

A"

11-2

POWER METER

432A

SN pre: 1141A—

SN 1141A08596

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simco electronics

THE CALIBRATION PROCEDURE ON PAGES 5-1

THRU 5-8 OF THIS PUBLICATION FOR: 6-72

INSTRUMENT Power Meter

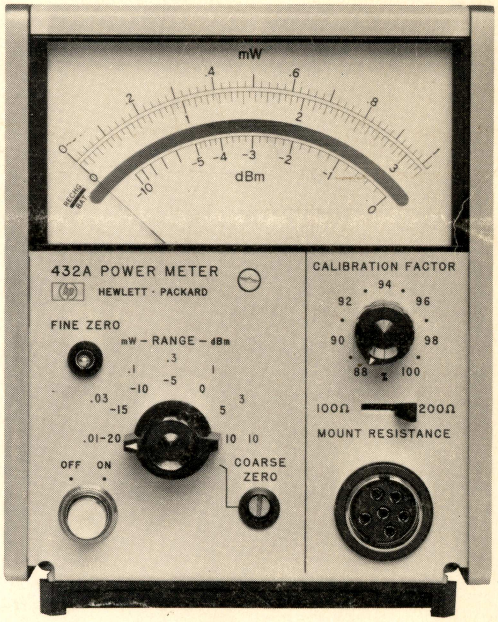
MODEL 432A

MANUFACTURER HP

HAS BEEN REVIEWED AND APPROVED FOR USE AS A CONTROLLED CALIBRATION PROCEDURE

DATE 10-10-2000 SIGNATURE

EMPL NO. 11522 TITLE QR


mW
dBm
432A POWER METER
HEWLETT · PACKARD
FINE ZERO
mW – RANGE – dBm
CALIBRATION FACTOR
MOUNT RESISTANCE
100Ω
200Ω
OFF ON
COARSE ZERO

HEWLETT hp PACKARD

HP 432A

CERTIFICATION

The Hewlett-Packard Company certifies that this instrument was thoroughly tested and inspected and found to meet its published specifications when it was shipped from the factory. The Hewlett-Packard Company further certifies that its calibration measurements are traceable to the U.S. National Bureau of Standards to the extent allowed by the Bureau's calibration facility.

WARRANTY AND ASSISTANCE

All Hewlett-Packard products are warranted against defects in materials and workmanship. This warranty applies for one year from the date of delivery, or, in the case of certain major components listed in the operating manual, for the specified period. We will repair or replace products which prove to be defective during the warranty period provided they are returned to Hewlett-Packard. No other warranty is expressed or implied. We are not liable for consequential damages.

Service contracts or customer assistance agreements are available for Hewlett-Packard products that require maintenance and repair on-site.

For any assistance, contact your nearest Hewlett-Packard Sales and Service Office. Addresses are provided at the back of this manual.

POWER METER

432A

SERIAL NUMBERS

This manual applies directly to instruments with serial numbers prefixed 1141A.

With changes described in Appendix I, this manual also applies to instruments with serial numbers prefixed 812-, 840-, 843-, 904-, 919-, 937-, 968-, 992-, and 1102A.

For additional information about serial numbers, see INSTRUMENT IDENTIFICATION in Section I.

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HEWLETT hp PACKARD

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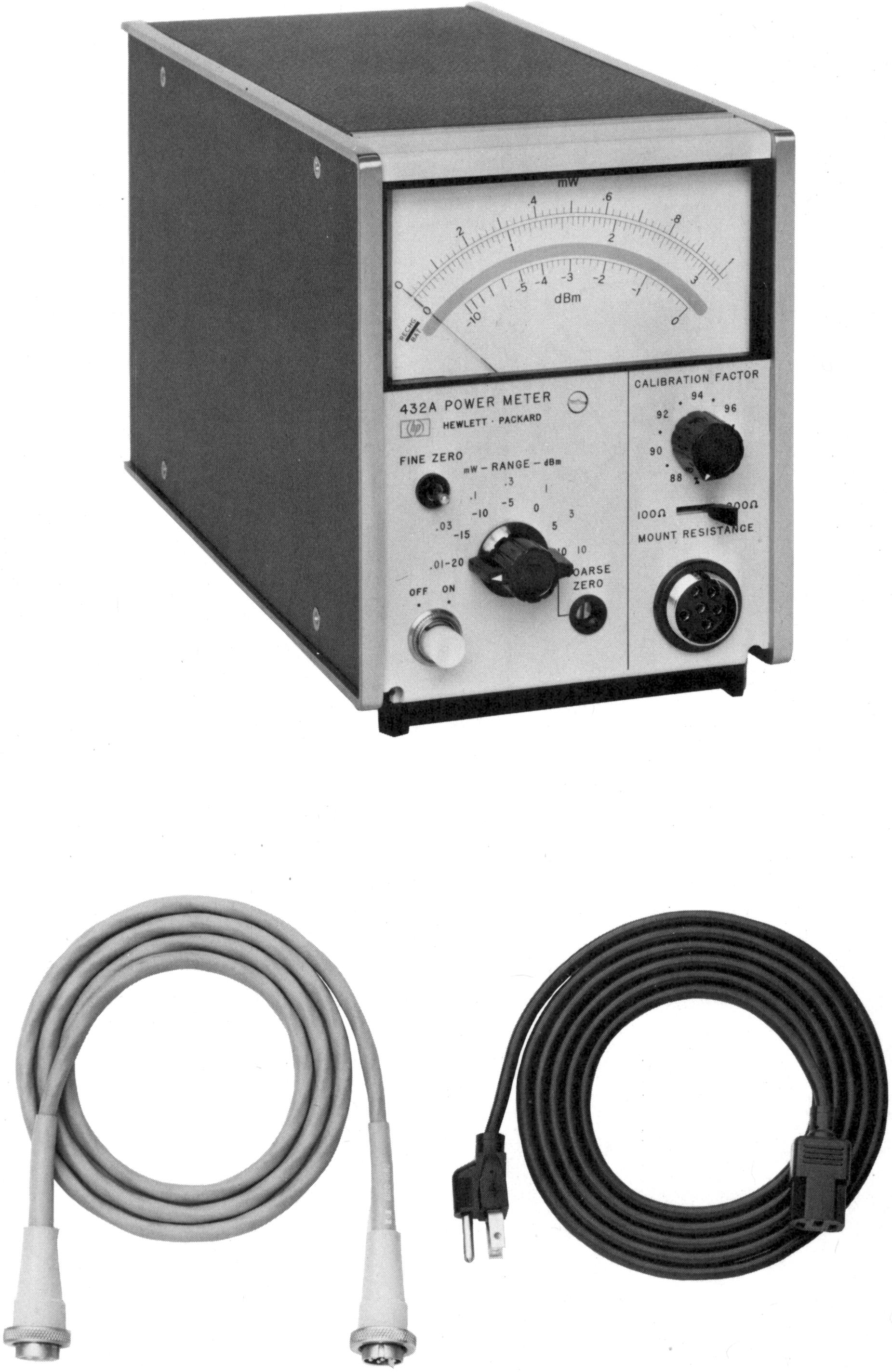

mW
dBm
RECHG BAT
432A POWER METER
HEWLETT · PACKARD
FINE ZERO
mW — RANGE — dBm
OFF ON
OARSE ZERO
CALIBRATION FACTOR
100Ω
MOUNT RESISTANCE

Figure 1-1. HP Model 432A Power Meter

SECTION I

GENERAL INFORMATION

1-1. DESCRIPTION.

1-2. The Hewlett-Packard Model 432A Power Meter, with HP temperature-compensated thermistor mounts, measures RF power from 10 microwatts (-20 dBm) to 10 milliwatts (+10 dBm) full scale with 1% of full scale accuracy from 10 MHz to 40 GHz. With a selector switch, the instrument normalizes the power meter reading to compensate for the Calibration Factor of a thermistor mount used for a given measurement. For portable operation, Option 01 instruments have a rechargeable nickel-cadmium battery. See Table 1-1 for complete specifications.

1-3. The Model 432A has provision for dc substitution measurements and for power meter calibration. An output is provided for recorders or digital voltmeter readout.

1-4. Accessories. Two accessories are supplied with the Model 432A Power Meter: a 7.5-foot (2290 mm) detachable power cable and a 5-foot (1520 mm) cable that connects the thermistor mount to the meter. Thermistor mounts are available but not supplied with the power meter (refer to Table 1-2). Table 1-1 lists those accessories supplied and also those available.

1-5. INSTRUMENT IDENTIFICATION.

1-6. Hewlett-Packard instruments are identified by an 8- or 10-digit serial number. The first three digits are the Serial Prefix. To properly match a manual with the instrument to which it applies, the prefix on the instrument must be the same as the prefix at the front of the manual. If the numbers are different, information is supplied either on yellow Manual Change Supplements, or in an Appendix in the Manual. If the change information is missing, contact your HP Sales Office (Sales Offices are listed at the back of the Manual).

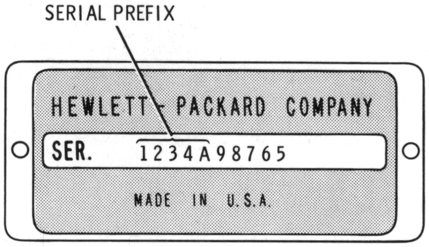


Figure 1-2. Instrument Identification

Table 1-1. Specifications

Instrument Type: Automatic, self-balancing power meter for use with temperature-compensated thermistor mount.

Power Range: 7 ranges with full-scale readings of 10, 30, 100, and 300 μW, 1, 3 and 10 mW; also calibrated in dBm from -20 dBm to +10 dBm full scale in 5-dB steps.

Accuracy: ±1% of full scale on all ranges (+0°C to +55°C).

Calibration Factor Control: 13-position switch normalizes meter reading to account for thermistor mount Calibration Factor.
Range: 100% to 88% in 1% steps.

Thermistor Mount: External temperature-compensated thermistor mounts required for operation (see Table 1-2).

Meter: Taut-band suspension, individually computer-calibrated, mirror-backed scales. Milliwatt scale more than 4-1/4 inches (108 mm) long.

Zero Carryover: Less than ±0.5% of full scale when zeroed on most sensitive range.

Fine Zero: Automatic, operated by toggle switch.

Recorder Output: 1.000 volt into open circuit corresponds to full-scale meter deflection (1.0 on 0-1 scale) ±0.5%; 1000-ohm output impedance, BNC connector.

RFI: Meets all conditions specified in MIL-I-6181D.

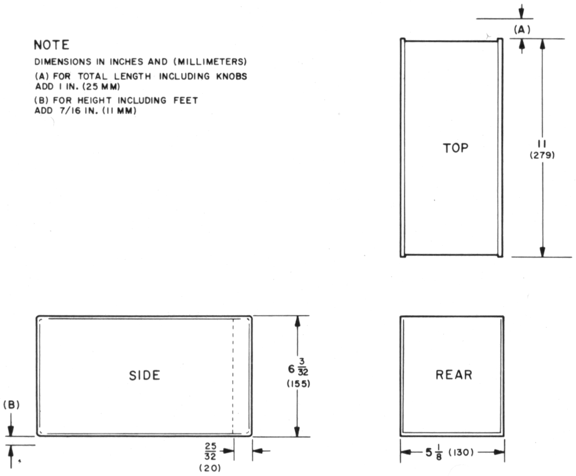
Power: 115 or 230 Vac ±10%, 48 to 440 Hz, 1-1/2 watts. Optional rechargeable battery provides up to 20 hours continuous operation. Automatic battery recharge.

Weight: Net 6-1/2 lb (3 kg).

Weight with Optional Battery Pack: Net 9-1/4 lb (4,2 kg).

Table 1-1. Specifications (Cont.)

Dimensions:


NOTE
DIMENSIONS IN INCHES AND (MILLIMETERS)
(A) FOR TOTAL LENGTH INCLUDING KNOBS ADD 1 IN. (25 MM)
(B) FOR HEIGHT INCLUDING FEET ADD 7/16 IN. (11 MM)
(A)
TOP
11
(279)
SIDE
6 3/32
(155)
(B)
25/32
(20)
REAR
5 1/8 (130)

Accessories Furnished: 5-ft (1,42 m) cable for HP temperature compensated thermistor mounts; 7-1/2 ft (2,29 m) power cable, NEMA plug.

Accessories Available:

00432-6016 Rechargeable Battery Pack for field installation.

5060-0797 Rack Adapter Frame (holds three instruments the size of the 432A).

8477A Power Meter Calibrator.

11076A Carrying Case.

Combining Cases:

1051A, 11-1/4 in. (286 mm) deep.
1052A, 16-3/8 in. (416 mm) deep.

The combining cases accept the 1/3-module HP instruments for bench use or rack mounting. See 1051A data sheet for details.

Options:

001: Rechargeable battery installed, provides up to 20 hours continuous operation.

002: Rear thermistor mount input connector wired in parallel with front panel input connector.

003: Input connector placed on rear panel instead of front.

Note

Thermistor mount cable impedance is part of the 432A input bridge circuit. For cables 20 feet long and over, the bridge is matched to specific cable options, so the various cables should not be interchanged.

009: 10-foot (3,05 m) cable for 100-ohm or 200-ohm mount.

010: 20-foot (6,10 m) cable for 100-ohm or 200-ohm mount.

011: 50-foot (15,24 m) cable for 100-ohm or 200-ohm mount.

012: 100-foot (30,48 m) cable for 100-ohm or 200-ohm mount.

013: 200-foot (60,96 m) cable for 100-ohm or 200-ohm mount.

Table 1-2. Thermistor Mounts for the 432A

HP Model	Frequency Range (GHz)	Operating Resistance (Ohms)
COAXIAL MOUNTS:		
478A (Type N Connector)	0.01-10	200
8478B (Type N Connector)	0.01-18	200
8478B-Option 11 (APC-7 Connector)	0.01-18	200
WAVEGUIDE MOUNTS:		
S486A	2.6-3.95	100
G486A	3.95-5.85	100
J486A	5.3-8.2	100
H486A	7.05-10	100
X486A	8.2-12.4	100
M486A	10-15	100
P486A	12.4-18	100
K486A	18-26.5	200
R486A	26.5-40	200
WAVEGUIDE MOUNT ACCESSORIES:		
11515A: Circular Flange Adapter for K486A.		
11516A: Circular Flange Adapter for R486A.		

SECTION II

INSTALLATION

2-1. INITIAL INSPECTION.

2-2. MECHANICAL CHECK.

2-3. If damage to the shipping carton is evident, ask that the carrier's agent be present when the instrument is unpacked. Inspect the instrument for mechanical damage. Also check the cushioning material for signs of severe stress.

2-4. PERFORMANCE CHECKS.

2-5. The electrical performance of the Model 432A should be verified upon receipt. Performance checks suitable for incoming inspection are given in Section V, Maintenance.

2-6. DAMAGE CLAIMS.

2-7. If the instrument is mechanically damaged in transit, notify the carrier and the nearest Hewlett-Packard field office immediately. A list of field offices is at the back of this manual. Retain the shipping carton and padding material for the carrier's inspection. The field office will arrange for replacement or repair of your instrument without waiting for claim settlements against the carrier.

2-8. Before shipment this instrument was inspected and found free of mechanical and electrical defects. If there is any deficiency, or if electrical performance is not within specifications, notify your nearest Hewlett-Packard Sales and Service Office.

2-9. THREE-CONDUCTOR POWER CABLE.

2-10. To protect operating personnel, the National Electrical Manufacturers Association (NEMA) recommends that the instrument panel and cabinet be grounded. All Hewlett-Packard instruments are equipped with a three-conductor power cable which, when plugged into an appropriate receptacle, grounds the instrument. The offset pin on the power cable three-prong connector is the ground wire.

2-11. To preserve the protection feature when operating the instrument from a two-connector outlet, use a three-prong to two-prong adapter and connect the green pigtail on the adapter to ground.

2-12. PRIMARY POWER REQUIREMENTS.

2-13. The Model 432A operates from 115 or 230 volts ac line voltage. Line frequency may vary from 48 to 440 Hz. A slide switch on the rear panel is moved to the correct position for the line voltage available. Before operating the equipment, ensure that the fuse installed in the instrument corresponds to the value marked on the panel for the line voltage available (1/8 amp slo-blow).

2-14. INTERNAL BATTERY OPERATION.

2-15. Model 432A Option 001 instruments contain an internal battery and a battery charging assembly. By connecting the 432A to an ac source, the battery may be charged overnight. The battery can be maintained in the charging state indefinitely without damage. It will assume its full capacity, 1.25 ampere-hours, and will not charge in excess of that. This enables the instrument to operate for approximately 20 hours continuously without recharging.

2-16. BATTERY INSTALLATION.

a. Set power switch to off and remove power plug from rear panel.

b. Remove top and bottom, and side instrument covers.

c. The battery is installed with the terminals toward the right hand side of the instrument when faced from the front. The two terminals on the battery fit into spaces provided on the circuit board.

d. Using the retaining nuts, fasten the battery firmly in place. Be careful not to short the battery terminals at any time as this may cause battery cell damage.

e. Install Assembly A7, battery charging board, in the space provided for it just ahead of the battery.

f. Reinstall instrument covers and adjust circuit. Instrument is now ready for operation.

2-17. BATTERY STORAGE.

2-18. Store the battery at or below room temperature. Extended storage at high temperature will reduce the cell charge, but will not damage the battery if the storage temperature is below 140°F. Install the battery in the instrument and recharge before using Model 432A in battery operation.

2-19. RACK MOUNTING.

2-20. Model 432A is narrower than full-rack width. It is what is termed a sub-modular unit. When used alone, the instrument can be bench mounted. When used in combination with other sub-modular units it may be bench or rack mounted. The HP 1051A and 1052A Combining Cases and Rack Adapter Frames are designed specifically for this purpose.

2-21. COMBINING CASE.

2-22. A model 1051A Combining Case is shown in Figure 2-1. This case is full rack width and accepts varying combinations of submodular instruments. The case, purchased separately, is provided with a rack mounting kit. The combining case will hold three

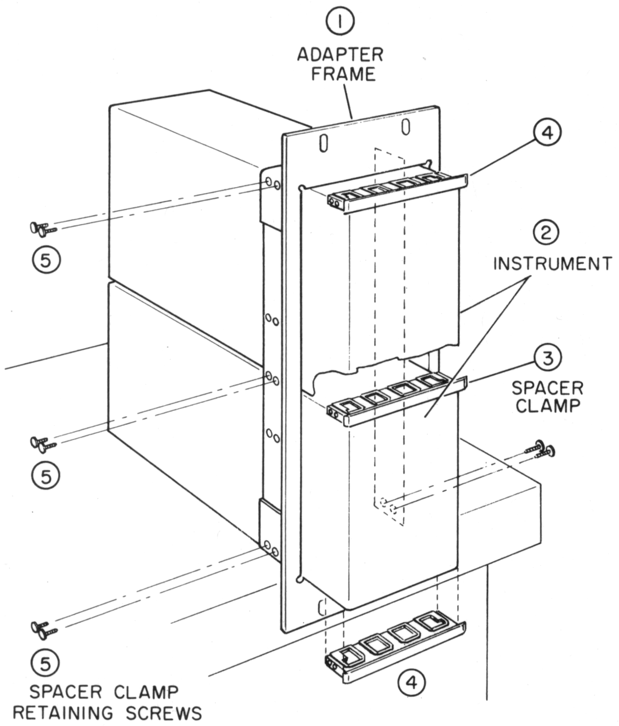

①
ADAPTER FRAME
②
INSTRUMENT
③
SPACER CLAMP
④
④
⑤
⑤
⑤
SPACER CLAMP RETAINING SCREWS

Figure 2-1. Sub-module Installation in Rack Adapter Frame

instruments the same size as the Model 432A. When instruments are installed in the combining case, they may be installed or removed individually.

2-23. ADAPTER FRAMES.

2-24. The 5060-0797 Adapter Frame is shown in Figure 2-2. The frame will accept a variety of submodular units in a manner suitable for rack mounting. Submodular units, in combination with any necessary spacers are assembled within the frame. A submodular unit cannot be removed individually.

2-25. REPACKING FOR SHIPMENT.

2-26. When returning an instrument to Hewlett-Packard use the original packing material. If the original foam type packing material is not available, contact an authorized HP Sales Office for assistance. If this is not possible, first protect the instrument surfaces by wrapping in heavy kraft paper or with sheets of cardboard flat against the instrument. Protect the instrument on all sides using approximately 4" of packing material and pack in a durable container. Mark the container clearly for proper handling and insure adequately before shipping.

2-27. When an instrument is returned to HP for service or repair, attach a tag to the instrument specifying the owner and desired action. All correspondence should identify the instrument by model number and full eight-digit serial number.

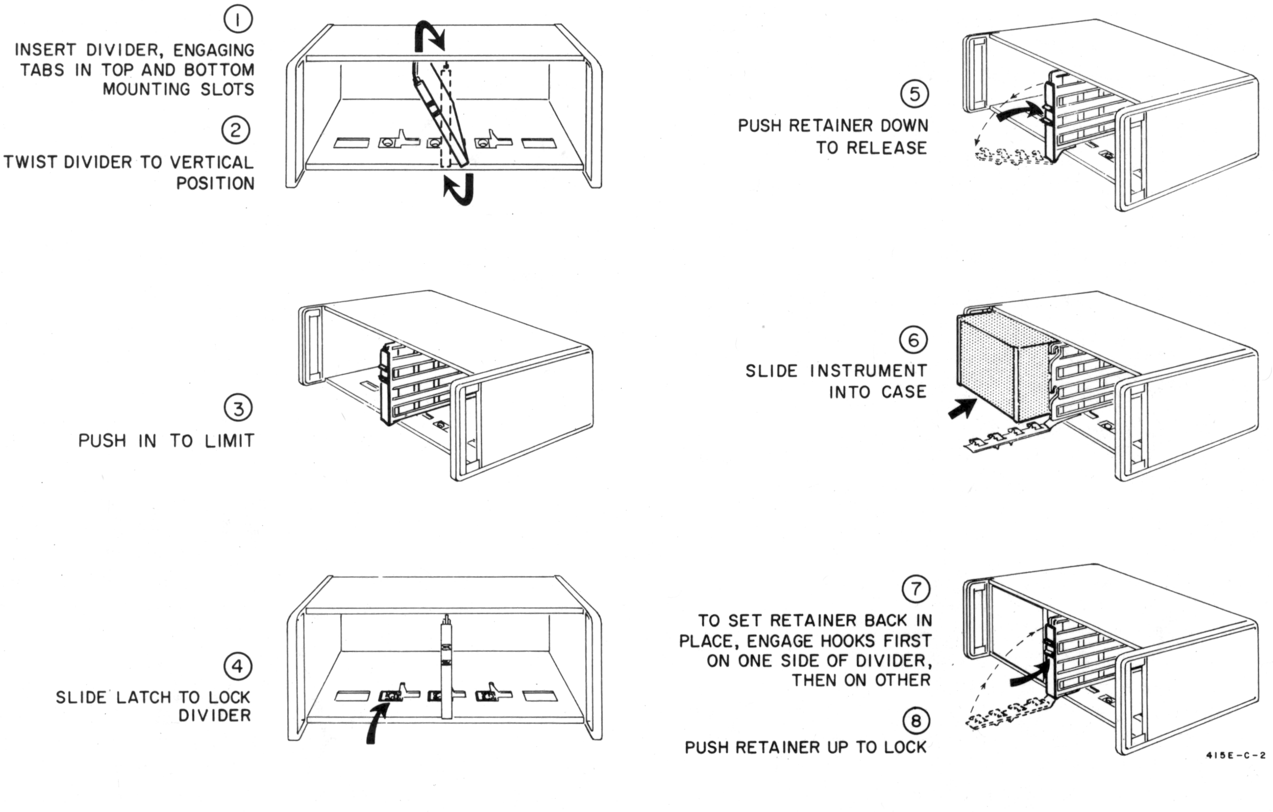

①
INSERT DIVIDER, ENGAGING TABS IN TOP AND BOTTOM MOUNTING SLOTS
②
TWIST DIVIDER TO VERTICAL POSITION
③
PUSH IN TO LIMIT
④
SLIDE LATCH TO LOCK DIVIDER
⑤
PUSH RETAINER DOWN TO RELEASE
⑥
SLIDE INSTRUMENT INTO CASE
⑦
TO SET RETAINER BACK IN PLACE, ENGAGE HOOKS FIRST ON ONE SIDE OF DIVIDER, THEN ON OTHER
⑧
PUSH RETAINER UP TO LOCK
415E-C-2

Figure 2-2. HP Model 1051A Combining Case Instrument Installation

SECTION III

OPERATING INFORMATION

3-1. INTRODUCTION.

3-2. The Model 432A Power Meter operates with HP temperature-compensated thermistor mounts such as the 8478B and 478A Coaxial, and 486A Waveguide series. The frequency range of the 432A with these mounts in 50-ohm coaxial systems is 10 MHz to 18 GHz; in waveguide systems it is 2.6 GHz to 40 GHz. Full-scale power ranges are 10 microwatts to 10 milliwatts (-20 dBm to +10 dBm). Extended measurements may be made to 1 microwatt (-30 dBm). The total measurement capacity of the instrument is divided into seven ranges, selected by a front-panel RANGE switch.

3-3. This section describes general operating procedures and error analysis in microwave power measurement. Application Note 64, available on request from Hewlett-Packard, is a detailed analysis of microwave power measurement problems and techniques.

3-4. CONTROLS, CONNECTORS, AND INDICATORS.

3-4. The front and rear panel controls, connectors, and indicators are explained in Figure 3-2. The descriptions are keyed to the corresponding items which are indicated on the figure.

3-6. The COARSE ZERO and FINE ZERO controls zero the meter. Zero carry-over from the most sensitive range to the other six ranges is within ±0.5%. When the RANGE switch is set to COARSE ZERO, the meter indicates thermistor bridge unbalance, and the front panel COARSE ZERO adjust is for initial bridge balance. For best results, FINE ZERO the 432A on the particular meter range in use.

3-7. The CALIBRATION FACTOR switch provides discrete amounts of compensation for measurement uncertainties related to SWR and thermistor mount efficiency. The Calibration Factor value permits direct meter reading of the RF Power delivered to an impedance equal to the characteristic impedance (Z_o) of the transmission line between the thermistor mount and the RF source. Calibration Factor values are marked on the label of each 8478B, 478A or 486A Thermistor Mount. For further details, see Paragraph 3-23.

3-8. The MOUNT RESISTANCE switch on the front panel compensates for three types of thermistor mounts. Model 486A waveguide mounts can be used by setting the MOUNT RESISTANCE switch to 100Ω or 200Ω, depending on the thermistor mount used (refer to Table 1-2). The 200Ω position is used with Models 478A and 8478B Thermistor Mounts.

3-9. The rear-panel BNC connected labeled RECORDER provides an output voltage linearly proportional to the meter current; 1 volt into an open circuit equals full-scale meter deflection. This voltage is developed across a 1K resistor; therefore, when a recorder with a 1K input impedance is connected to the RECORDER output, approximately .5 volt will equal full scale deflection. This loading of the RECORDER output has no effect on the accuracy of the 432A panel meter.

3-10. A digital voltmeter can be connected to the rear panel RECORDER output for more resolution of power meter readings. When a voltmeter with input impedance greater than 1 megohm is connected to the RECORDER output, 1 volt equals full scale deflection.

3-11. The 432A has two calibration jacks (V_{RF} and V_{COMP}) on the rear panel that can be used for precision power measurements. Instrument error can be reduced from ±1% to ±(0.2% of reading +5μW) of reading, depending on the care taken in measurement and on the accuracy of auxiliary equipment. For further information, see Paragraph 3-27.

3-12. BATTERY OPERATION.

3-13. The Model 432A Option 001 instruments contain tery and conventional 115- or 230-volt line power. A rechargeable Nickel-Cadmium battery is factory-installed in Option 01 instruments. The same battery can be ordered and later installed on the basic instrument, thereby modifying the power meter to the Option 01 configuration. The battery installation kit, HP part number 00432-6016 (including battery charging circuit) may be ordered from the nearest HP Sales Office.

3-14. It is recommended that the Model 432A be battery-operated for up to eight hours, and then allowed to recharge eight hours, or overnight. Continuous battery operation is possible for up to about 20 hours, but then the battery must be recharged for about 20 hours.

3-15. The 432A automatically operates on its internal battery whenever the ac line power is disconnected and the POWER switch is ON. When the battery terminal voltage decreases far enough to force the power supply voltage regulator out of regulation, then the meter stops working and the meter indicator points to the red RECHG BAT. To recharge the battery, simply connect the 432A to ac line power, and turn it ON.

3-16. Battery Storage. Storage of the battery at or below room temperature is best. Extended storage at temperatures above room temperature will reduce cell charge, but will not damage the battery; however, the battery should not be stored where the temperature exceeds 60°C (+140°F).

3-17. MICROWAVE POWER MEASUREMENT ACCURACY.

3-18. A number of factors affect the overall accuracy of power measurement. The major sources of error are mismatch error, RF losses, and instrumentation error.

3-19. Mismatch Error. In a practical measurement situation, both the source and thermistor mount have SWR, and the source is seldom matched to the thermistor mount unless a tuner is used. The amount of mismatch loss in any measurement depends on the total SWR present. The impedance that the source sees is determined by the acutal thermistor mount impedance, the electrical length of the line, and the characteristic impedance of the line, Z_0.

3-20. In general, neither the source nor the thermistor mount has Z_0 impedance, and the actual impedances are known only as reflection coefficients, mismatch losses, or SWR. The power delivered to the thermistor mount - and hence the mismatch loss - can only be described as being somewhere between two limits. The uncertainty of power measurement due to mismatch loss increases with SWR. Limits of mismatch loss are generally determined by means of a chart such as the Mismatch Loss Limits charts in Application Note 64. The total mismatch loss uncertainty in power measurement is determined by algebraically adding the thermistor mount losses to the uncertainty caused by source and thermistor mount Z_0 match.

3-21. RF Losses. RF losses account for the power entering the thermistor mount but not dissipated in the detection thermistor element. Such losses may be in the walls of a waveguide mount, the center conductor of a coaxial mount, capacitor dielectric, poor connections within the mount, or due to radiation.

3-22. Instrumentation Error. The degree of inability of the instrument to measure the substitution power supplied to the thermistor mount is called power meter accuracy or instrumentation error. Instrumentation error of the Model 432A is ±1% of full scale, 0°C to +55°C.

3-23. CALIBRATION FACTOR AND EFFECTIVE EFFICIENCY.

3-24. Calibration factor and effective efficiency are correction factors for improving power measurement accuracy. Both factors are marked on every HP thermistor mount. Calibration factor compensates for thermistor mount VSWR and RF losses whenever the thermistor mount is connected to an RF source without a tuner. Effective efficiency compensates for thermistor mount RF losses when a tuner is used in the measurement system.

3-25. When the 432A CALIBRATION FACTOR selector is set to the appropriate factor indicated on the thermistor mount, the power indicated by the meter is the power that would be delivered by the source to a load impedance equal to Z_0. More accurately, the relationship between indicated power and the power available to a Z_0 load is given by the following equation:

$$P_o = \frac{P \text{ indicated } (1 \pm \rho_s \rho_m)^2}{\text{Calibration Factor}}$$

where

P_o = power available to a Z_0 load

ρ_s = source reflection coefficient

ρ_m = thermistor mount reflection coefficient

$$\rho = \frac{SWR - 1}{SWR + 1}$$

Calibration factor does not compensate for source VSWR, or for multiple reflections between the source and the thermistor mount.

3-26. To minimize mismatch between the source and the thermistor mount without a tuner, insert a low SWR precision attenuator in the transmission line between the thermistor mount and the source. Since the mount impedance (and corresponding SWR) deviates signifcnatly only at the high and low ends of a microwave band, it is generally unnecessary to use a tuner. A tuner or other effective means of reducing mismatch error is recommended when the source SWR is high or when more accuracy is required. For further details, there is a complete discussion of microwave power measurement with emphasis on modern techniques, accuracy considerations and sources of error available in Application Note 64.

3-27. PRECISION POWER MEASUREMENT.

3-28. GENERAL.

3-29. Using precision instruments and careful procedures, measurement error can be reduced to ±0.2% of reading +0.5 μW. The technique involves: 1) zeroing the bridge circuits and measuring the bridge amplifier output voltage difference with a digital voltmeter, then 2) connecting RF power to the thermistor mount and then measuring the bridge amplifier output voltage difference again, and 3) calculating the power from the two measurements. Figure 3-1 shows the instrument setup for dc substitution measurement. Use an HP Model 3440A DVM, with a 3443A Plug-in Unit or a digital voltmeter with equivalent accuracy.

3-30. MEASUREMENT PROCEDURE.

a. Connect the DVM to the 432A rear panel V_{comp} and V_{RF} outputs. Be sure that the digital voltmeter input is isolated from chasses ground.

b. Turn off, or disconnect the RF power from the thermistor mount.

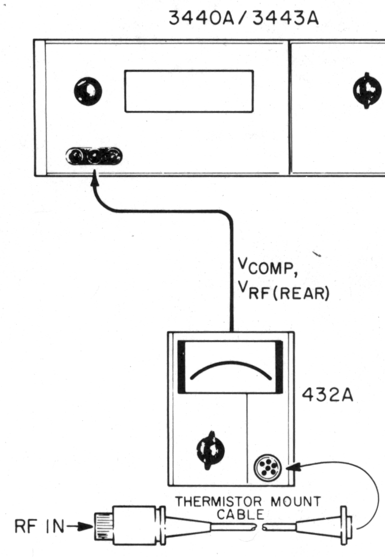


Figure 3-1. Precision Power Measurements

c. Zero the 432A with the COARSE ZERO controls.

d. Depress the FINE ZERO toggle, and measure the differential voltage (V_0) between V_{comp} and V_{RF}.

$$V_0 = V_{COMP} - V_{RF}$$

e. Release the FINE ZERO toggle, and turn on, or reconnect the RF power to the thermistor mount.

f. Measure again the differential voltage (V_1) between V_{RF} and V_{COMP}.

$$V_1 = V_{COMP} - V_{RF}$$

g. Measure V_{COMP} to ground.

h. Calculate incident RF power from the equation

$$P_{RF} = \frac{\frac{1}{4R}\left[2\,V_{COMP}(V_1 - V_0) + V_0^2 - V_1^2\right]}{\text{EFFECTIVE EFFICIENCY}}$$

where
R is the thermistor mount resistance.

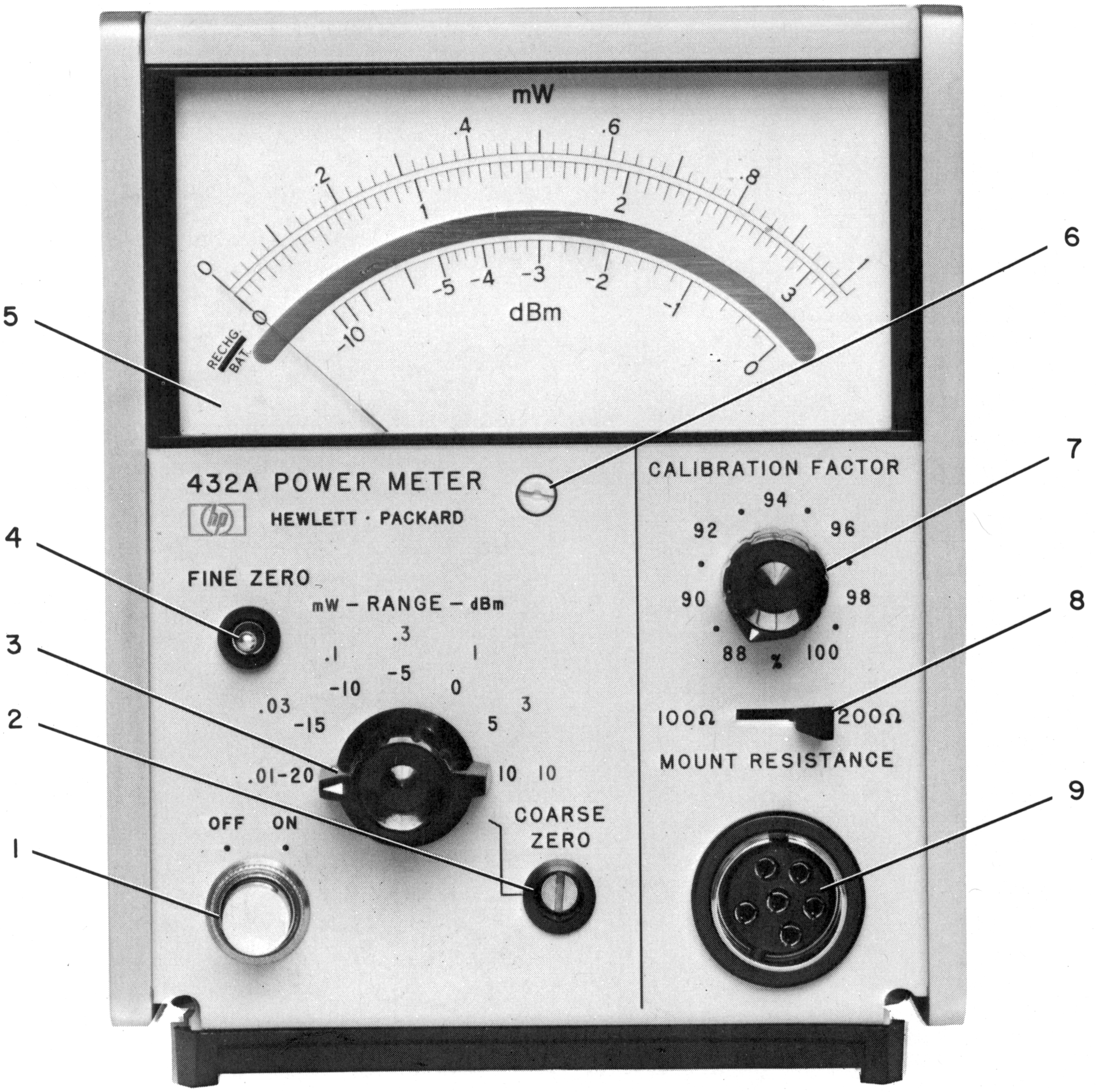

1
2
3
4
5
6
7
8
9
mW
dBm
RECHG BAT
432A POWER METER
HEWLETT · PACKARD
FINE ZERO
mW – RANGE – dBm
OFF
ON
COARSE ZERO
CALIBRATION FACTOR
%
100Ω
200Ω
MOUNT RESISTANCE

Figure 3-2. Front Panel Controls, Connectors and Indicators (Sheet 1 of 2)

1. POWER. Instrument power ON/OFF switch; connects either ac line voltage or internal battery (Option 01 only) to internal voltage regulator circuits. When ac power is on, optional battery charging circuit operates.

2. COARSE ZERO. Meter zero adjustment; set the RANGE selector to COARSE ZERO, turn OFF the RF power, and adjust to zero the meter.

3. RANGE. Power measurement range selector; selects ranges from 0.01 to 10 milliwatts (-20 to +10 dBm). COARSE ZERO setting is used to zero meter with no power applied to thermistor mount.

4. FINE ZERO. Electronic zero that balances the compensation bridge with zero RF input. To zero meter during operation, close the switch momentarily. Be sure that RF power is not applied to the thermistor mount when the FINE ZERO switch is depressed.

5. Meter. Indicates power input to thermistor mount in milliwatts and dBm. To use the dBm scale, note the value in dBm of the range in use, and subtract from it the reading on the meter dBm scale.

6. Mechanical Meter Zero. Sets meter suspension so that meter indicates zero. To adjust the zero:
   a. Turn POWER switch off.
   b. Turn the adjustment screw clockwise until the indicator falls below zero and comes back up to zero again.
   c. Turn the adjustment very slightly counterclockwise to free up the mechanism from the adjusting peg.

7. CALIBRATION FACTOR. Amplifier gain compensation selector. Set to correspond to the calibration factor printed on the thermistor mount body. See Paragraph 3-23 for more information.

8. MOUNT RESISTANCE. Selects resistance equal to that of mount in use to balance bridges. Table 1-2 lists Hewlett-Packard thermistor mounts and resistances. Set with meter power OFF, when mount is initially connected to the meter.

9. Thermistor Mount Cable Connector. Input connector for 5-1/2 foot cable that connects to the 478A, 8478B, or 486A Thermistor Mounts.

Figure 3-2. Front Panel Controls, Connectors and Indicators (Sheet 2 of 2)

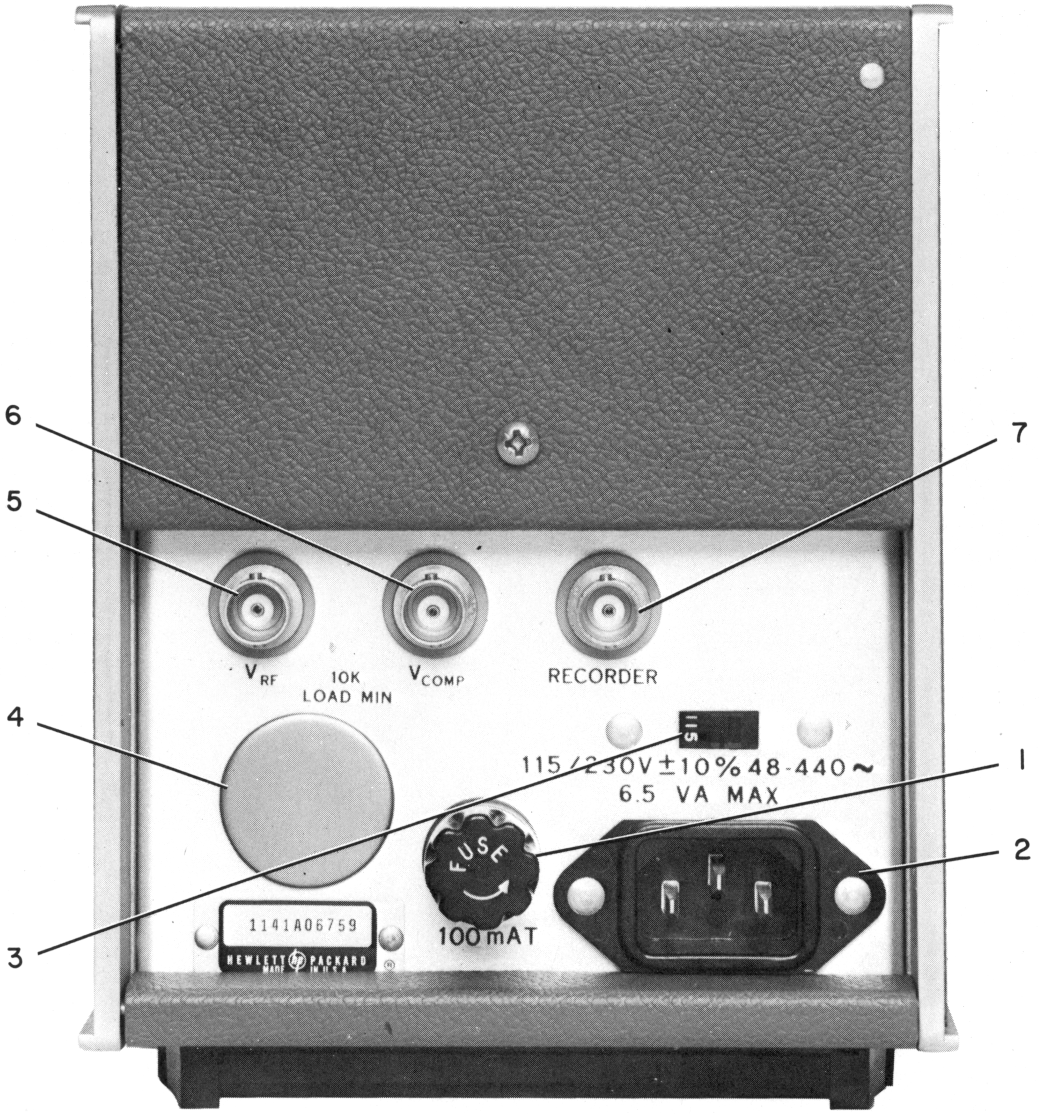

6
5
4
3
7
1
2
V_RF
10K
LOAD MIN
V_COMP
RECORDER
115
115/230V ±10% 48-440 ~
6.5 VA MAX
FUSE
100 mAT
1141A06759
HEWLETT PACKARD
MADE IN U.S.A.

Figure 3-3. Rear Panel Controls and Connectors (Sheet 1 of 2)

1. Line Fuse. For 115 Vac or for 230 Vac use 1/8 amp fuse.

2. Power Cord Input. Use power cord provided, HP 8120-0078. Line power limits are 115/230 Vac, 48-440 Hz. Check FUSE rating and position of line voltage slide switch before connecting power.

3. Line Voltage Slide Switch: Set to line voltage available (115 or 230 Vac, 48-440 Hz).

4. Mounting Hole for Option 002 Model Power Meters. Thermistor mount cable connector installed and wired in parallel with front-panel connector. Only one mount at a time may be used with the power meter.

5. V_{RF} Input. Connected directly to RF bridge. Used for calibrating power meter with HP 8477A Power Meter Calibrator. Also used for precision power measurements.

6. V_{COMP} Input. Connected directly to compensation bridge. Used for calibrating power meter with HP 8477A Power Meter Calibrator. Also used for precision power measurements.

7. RECORDER OUTPUT. Voltage from meter circuit to be used for recorder or digital voltmeter. Output impedance is approx. 1000Ω.

Figure 3-3. Rear Panel Controls and Connectors (Sheet 2 of 2)

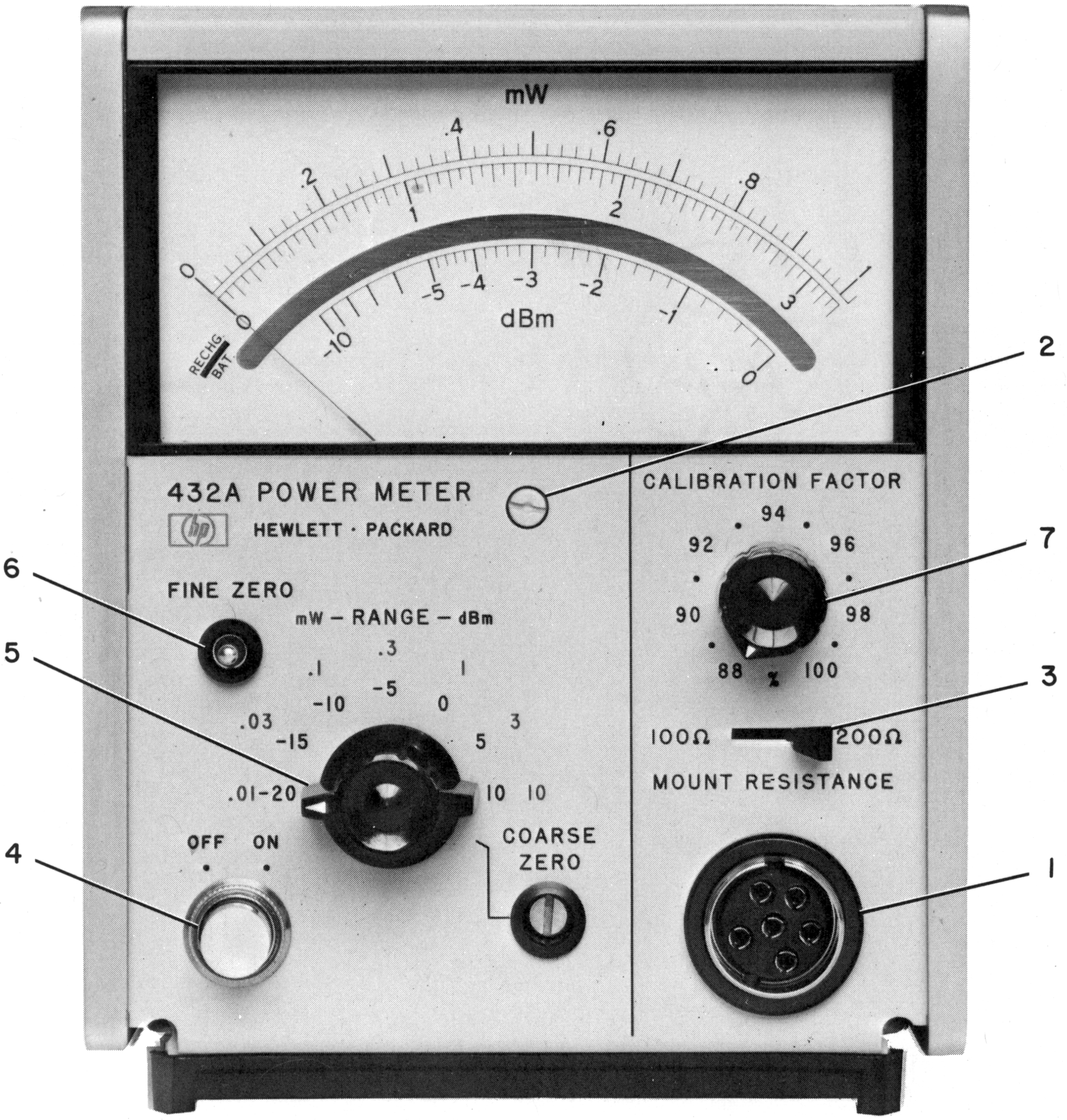

mW
0
.2
.4
.6
.8
1
0
1
2
3
-10
-5
-4
-3
-2
-1
0
dBm
RECHG BAT
432A POWER METER
HEWLETT · PACKARD
FINE ZERO
mW – RANGE – dBm
.01-20
.03
-15
.1
-10
.3
-5
1
0
3
5
10
10
OFF
ON
COARSE ZERO
CALIBRATION FACTOR
88
90
92
94
96
98
100
%
100Ω
200Ω
MOUNT RESISTANCE
1
2
3
4
5
6
7

Figure 3-4. Turn On and Zeroing Procedure (Sheet 1 of 2)

1. Connect the thermistor mount and cable to THERMISTOR MOUNT connector. Refer to Table 1-2 for recommended thermistor mounts and their frequency ranges.

2. Meter Mechanical Zero:
   a. With the instrument turned off, rotate the meter adjustment screw clockwise until the pointer approaches the zero mark from the left.
   b. Continue the clockwise rotation until the pointer coincides with the zero mark. If the pointer overshoots, continue rotating the adjustment screw clockwise until the pointer once again approaches the zero mark from the left.
   c. Rotate the adjustment screw about three degrees counterclockwise to disengage screw adjustment from the meter suspension.

3. Set the MOUNT RES switch to correspond to the operating resistance of thermistor mount used.

4. Turn the 432A POWER switch ON. For battery operation, the AC LINE indicator does not turn on.

5. Set the RANGE selector to COARSE ZERO and then zero the meter with the COARSE ZERO screwdriver adjustment.

Note

The power meter should be zeroed with the RF power source turned off, or the mount disconnected from the source.

6. Set the range selector to the 0.01 mW range; then depress the FINE ZERO switch until the meter indicates zero.

Note

Range-to-range zero carryover is less than ±0.5% if the meter zero has been adjusted (step 2 above), and the instrument has been properly zero-set on the sensitive range. For maximum accuracy, zero-set the power meter on the range to be used.

7. Set CALIB FACTOR switch to correspond to Calibration Factor imprinted on HP thermistor mount label.

8. Apply RF power to the thermistor mount. Power is indicated on the meter directly in mW or dBm.

Figure 3-4. Turn On and Zeroing Procedure

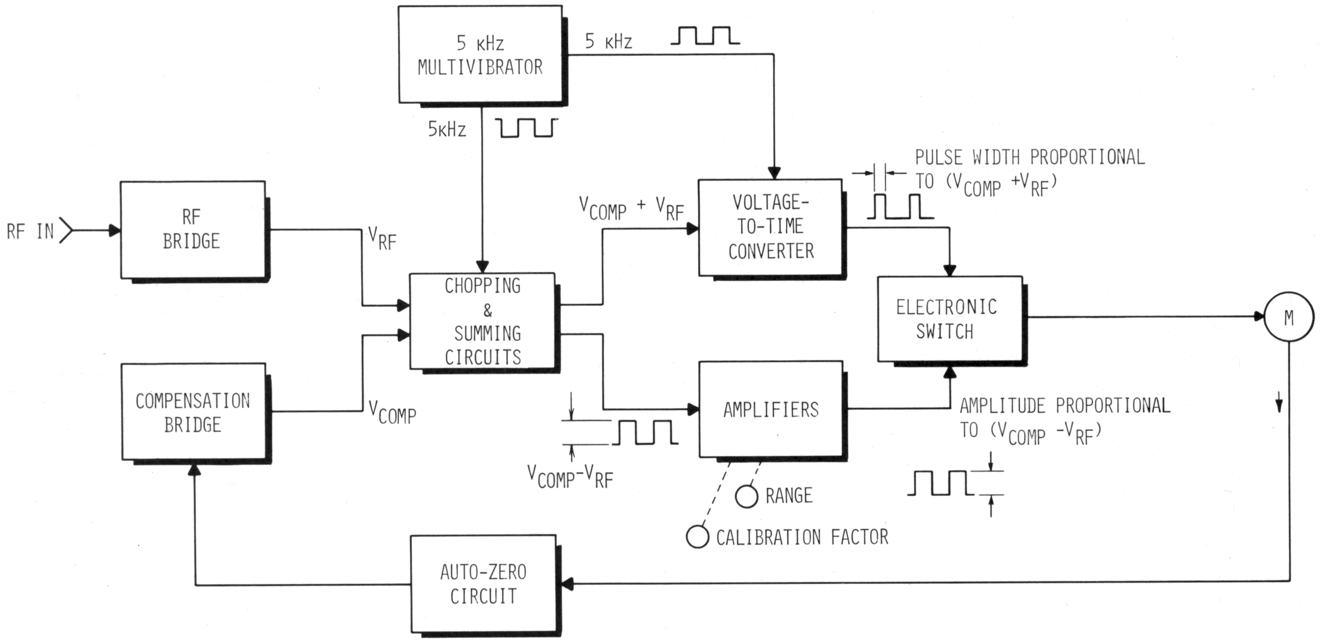

5 kHz MULTIVIBRATOR
5 kHz
5kHz
RF IN
RF BRIDGE
V_{RF}
CHOPPING & SUMMING CIRCUITS
COMPENSATION BRIDGE
V_{COMP}
$V_{COMP} + V_{RF}$
VOLTAGE-TO-TIME CONVERTER
PULSE WIDTH PROPORTIONAL TO ($V_{COMP} + V_{RF}$)
ELECTRONIC SWITCH
M
AMPLIFIERS
$V_{COMP} - V_{RF}$
AMPLITUDE PROPORTIONAL TO ($V_{COMP} - V_{RF}$)
RANGE
CALIBRATION FACTOR
AUTO-ZERO CIRCUIT

Figure 4-1. Simplified 432A Block Diagram

SECTION IV
PRINCIPLES OF OPERATION

4-1. SIMPLIFIED DESCRIPTION

4-2. The HP 432A Power Meter consists of two major sections: the bridge and meter logic assemblies. The instrument also contains an auto zero circuit which provides for automatic zeroing on any range. A simplified block diagram of the HP 432A is shown in Figure 4-1.

4-3. The bridge section contains circuits which form two self-balancing bridge circuits when a suitable thermistor mount is connected to the 432A. Each bridge is automatically brought to balance by the action of a high gain dc amplifier feeding power to the top of the bridge. The voltage at the top of the RF bridge, V_{RF} is responsive to both input RF power and ambient temperature changes. The voltage at the top of the compensation bridge, V_{COMP} is responsive only to ambient temperature changes. Knowing V_{RF} and V_{COMP}, the RF power can be calculated.

4-4. The meter logic section processes V_{RF} and V_{COMP} to produce a meter current proportional to RF power. The sum $(V_{RF} + V_{COMP})$ controls the width of 5 kHz pulses. The difference $(V_{COMP} - V_{RF})$ is chopped, amplified and fed to an electronic switch actuated by the controlled width pulses. Therefore, the meter current is pulses of variable height and width with the meter indicating the average current. (This process produces a meter current proportional to $(V_{RF} + V_{COMP})(V_{RF} - V_{COMP})$. Paragraph 4-10 explains why this is necessary.

4-5. FUNCTIONAL BLOCK DIAGRAM

4-6. A functional block diagram of the 432A power meter is shown in Figure 4-2. The instrument comprises two major assemblies: bridge assembly A1 and meter logic assembly A2. Auto zero circuit A1A1, which provides for automatic zeroing of the instrument, is included as part of logic assembly A1.

4-7. The thermistor bridges are biased with direct current from the bridge amplifiers. Each bridge amplifier supplies enough heating current to bring the thermistor resistance to 100 or 200 ohms, depending upon the setting of the MOUNT RESISTANCE switch on the 432A. If one of the thermistor bridges is unbalanced due to incorrect thermistor resistance, an error voltage occurs and is amplified by the bridge amplifier. The error voltage is applied to the top of the bridge and changes the power dissipation of the negative temperature coefficient thermistor. The change of power dissipation causes the resistance to the thermistor to change in the direction required to balance the bridge. Application of RF power to the RF bridge heats the thermistor and lowers its resistance. The bridge circuit responds by reducing the dc voltage applied to the top of the bridge thus maintaining bridge balance.

4-8. If ambient temperature causes changes in the thermistor resistance, the bridge circuits respond by applying an error voltage to the bridges to maintain bridge balance. The voltage at the top of the RF bridge is dependent upon both ambient temperature and the RF input. The voltage at the top of the compensation bridge is dependent upon the ambient temperature only. The power meter reading is brought to zero with no applied RF power by making V_{COMP} equal to V_{RF} so $(V_{COMP} - V_{RF})$ equals zero. Since ambient temperature causes both thermistors to respond similarly, there will be no net difference between the amplifier output voltages. Therefore, any difference in output volrages from the bridges is now due to RF power absorbed by the thermistor mount.

4-9. The RF bridge voltage, V_{RF}, and the compensation bridge voltage, V_{COMP}, contain the "RF power" information. To provide a meter reading proportional to RF power the dc voltages (V_{RF}, V_{COMP}) must be further processed by the meter logic circuits.

4-10. The required processing is derived as follows: P_o is absorbed power needed by the RF thermistor to bring its resistance to R ohms (100 or 200 ohms). P_o consists of two components: RF power and dc power supplied by the 432A. The self-balancing action of the bridge circuit automatically adjusts the dc power so that the total power in the thermistor is P_o. This dc power is related to the voltage V_{RF} at the top of the bridge by $(V_{RF}/2)^2/R$. Thus

$$P_o = \text{RF power} + \text{DC power}$$

$$= \text{RF power} + \frac{V_{RF}^2}{4R}$$

4-11. RF power can be determined by measuring V_{RF} with and without applied RF power and then doing some arithmetic. But this power measuring scheme is neither convenient nor temperature compensated (since P_o changes with temperature). The 432A introduces another thermistor bridge circuit exposed to the same ambient temperature but not RF power. This circuit includes adjustments (COARSE and FINE ZERO) so that the dc voltage V_{COMP} at the top of its bridge can be set equal to V_{RF}. Assuming matched RF and compensation thermistors, V_{RF0} (with no RF power) and V_{COMP} remain equal with ambient temperature fluctuation. They differ only when the RF power to be measured is applied to the RF thermistor. Thus, we have

$$V_{COMP} = V_{RF_0} \text{ when RF power } = 0$$

and

$$P_o = 0 + \frac{V_{COMP}^2}{4R}$$

Combining equations, we have:

$$\frac{V_{COMP^2}}{4R} = \text{RF power} + \frac{V_{RF^2}}{4R}$$

or

$$\text{RF power} = \frac{V_{COMP^2} - V_{RF^2}}{4R}$$

$$= \frac{1}{4R}\left(V_{COMP} + V_{RF}\right)\left(V_{COMP} - V_{RF}\right)$$

4-12. Thus an RF power measurement reduces to setting VCOMP = VRF0 (with zero RF power) initially, measuring VCOMP and VRF, and computing with the above formula. The 432A carries out the computation by forming the indicated sum and difference, performing the multiplication and displaying the result on a meter.

4-13. The meter logic circuits change the two dc voltages to two pulse signals which contain all the RF power information. One of the signals will be a square wave whose amplitude is proportional to VCOMP - VRF. The other signal will have a pulse width proportional to V_{COMP} + VRF.

4-14. The V_{COMP} - V_{RF} signal is obtained by taking the dc voltage outputs from the A1 assembly and applying them to a chopper circuit. This chopper circuit is driven by a 5-kHz multivibrator. The output of the chopper is a square wave signal whose amplitude is proportional to V_{COMP} - V_{RF}. The output of the chopper is coupled to the range amplifier and then to the calibration factor amplifier. The amplification that the signal receives in these two amplifiers depends upon the setting of the RANGE switch and the CALIBRATION FACTOR switch. The output of the calibration factor amplifier is V. This current is fed to the electronic switch. A square wave current with amplitude proportional to (V_{COMP} - V_{RF}).

4-15. The V_{COMP} + V_{RF} signal is obtained by taking the two dc voltages from A1 assembly through a summing circuit and feeding this voltage to a voltage-to-time converter. The voltage-to-time converter is driven by a 5-kHz multivibrator. The output of the voltage-to-time converter is a signal whose pulse width is proportional to the sum of VCOMP + VRF. This signal controls the electronic switch. From the VCOMP - V_{RF} and VCOMP + V_{RF} inputs, the electronic switch provides a 5-kHz pulse train whose amplitude is proportional to VCOMP - V_{RF} and whose pulse width is proportional to V_{COMP} + V_{RF}. The pulse width is always 90 msec or less.

4-16. The bias circuit switch and filter provides a zero current reference for the meter circuits. This is accomplished by controlling the dc bias to the first stage of the calibration factor amplifier. This circuit, in effect, restores the dc component to the square wave which has been amplified by ac coupled amplifiers.

4-17. The meter is a 0-1 mA, full-scale meter that has a capacitor across its terminals. The capacitor integrates the output pulses from the current switch so the current into the meter is proportional to the time average of the input pulses. That is, the input current to the meter is proportional to the product of

$$\left(V_{COMP} + V_{RF}\right)\left(V_{COMP} - V_{RF}\right)$$

$$= \left(V_{COMP}\right)^2 - \left(V_{RF}\right)^2$$

4-18. The output from the meter is further filtered so the voltage at the rear panel RECORDER output is suitable for use with either a digital voltmeter or X-Y recorder. The RECORDER output voltage is returned to the compensation bridge through the automatic zero circuit when the FINE ZERO switch is depressed. The automatic zero circuit holds a correction voltage at the input of the compensation bridge amplifier, so when the RF is zero, the meter indication will also be zero.

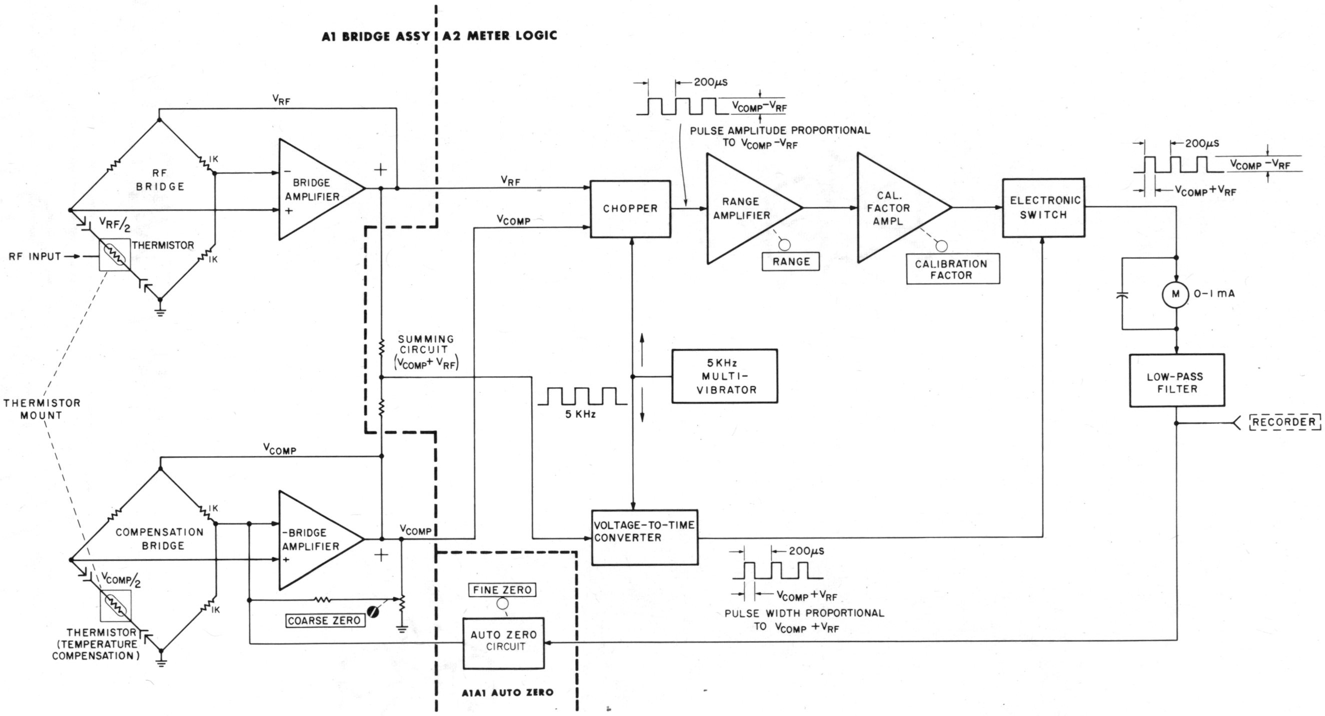

A1 BRIDGE ASSY
A2 METER LOGIC
V_{RF}
RF BRIDGE
IK
BRIDGE AMPLIFIER
$V_{RF}/2$
THERMISTOR
RF INPUT
CHOPPER
V_{COMP}
200μs
$V_{COMP}-V_{RF}$
PULSE AMPLITUDE PROPORTIONAL TO $V_{COMP}-V_{RF}$
RANGE AMPLIFIER
RANGE
CAL. FACTOR AMPL
CALIBRATION FACTOR
ELECTRONIC SWITCH
$V_{COMP}+V_{RF}$
M
0-1 mA
LOW-PASS FILTER
RECORDER
SUMMING CIRCUIT ($V_{COMP}+V_{RF}$)
5 KHz MULTI-VIBRATOR
5 KHz
THERMISTOR MOUNT
COMPENSATION BRIDGE
-BRIDGE AMPLIFIER
$V_{COMP}/2$
VOLTAGE-TO-TIME CONVERTER
PULSE WIDTH PROPORTIONAL TO $V_{COMP}+V_{RF}$
FINE ZERO
COARSE ZERO
AUTO ZERO CIRCUIT
THERMISTOR (TEMPERATURE COMPENSATION)
A1A1 AUTO ZERO

Figure 4-2. Model 432A Block Diagram

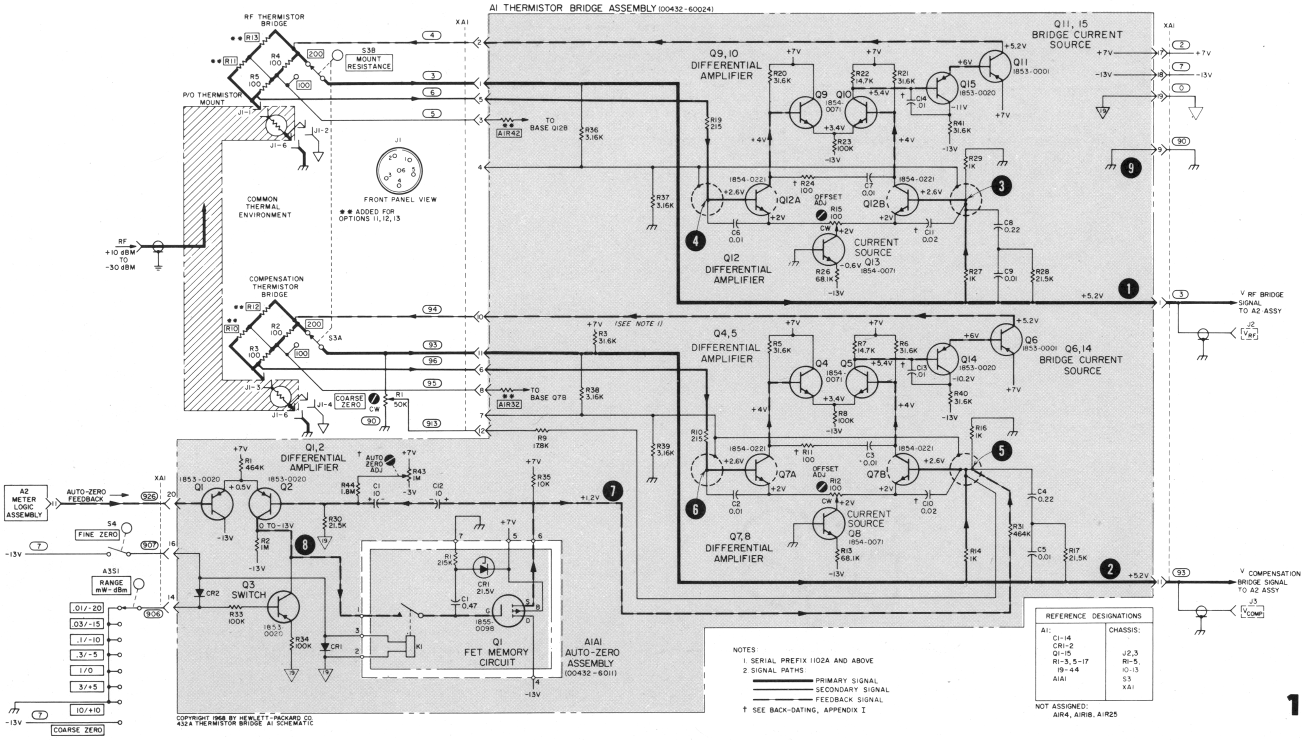
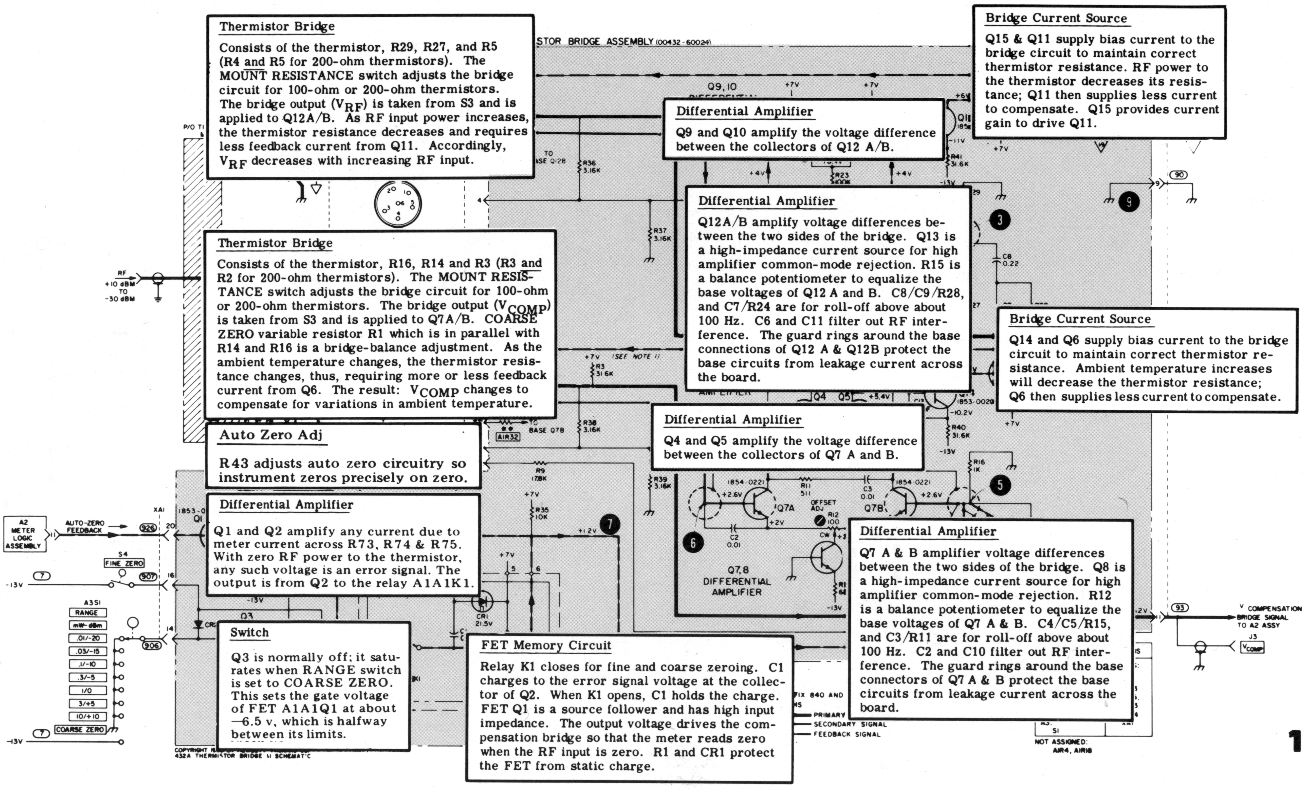

A1 THERMISTOR BRIDGE ASSEMBLY (00432-60024)
RF THERMISTOR BRIDGE
S3B MOUNT RESISTANCE
P/O THERMISTOR MOUNT
COMMON THERMAL ENVIRONMENT
J1 FRONT PANEL VIEW
** ADDED FOR OPTIONS 11, 12, 13
RF +10 dBM TO -30 dBM
COMPENSATION THERMISTOR BRIDGE
S3A
COARSE ZERO
Q9, 10 DIFFERENTIAL AMPLIFIER
Q11, 15 BRIDGE CURRENT SOURCE
Q12 DIFFERENTIAL AMPLIFIER
CURRENT SOURCE Q13
OFFSET ADJ
Q4, 5 DIFFERENTIAL AMPLIFIER
Q6, 14 BRIDGE CURRENT SOURCE
Q7, 8 DIFFERENTIAL AMPLIFIER
CURRENT SOURCE Q8
(SEE NOTE 1)
TO BASE Q12B
TO BASE Q7B
V RF BRIDGE SIGNAL TO A2 ASSY
V COMPENSATION BRIDGE SIGNAL TO A2 ASSY
J2 V RF
J3 V COMP
A2 METER LOGIC ASSEMBLY
AUTO-ZERO FEEDBACK
S4 FINE ZERO
A3S1 RANGE mW-dBm
.01/-20
.03/-15
.1/-10
.3/-5
1/0
3/+5
10/+10
COARSE ZERO
Q1, 2 DIFFERENTIAL AMPLIFIER
AUTO ZERO ADJ
Q3 SWITCH
Q1 FET MEMORY CIRCUIT
A1A1 AUTO-ZERO ASSEMBLY (00432-6011)
NOTES:
1. SERIAL PREFIX 1102A AND ABOVE
2. SIGNAL PATHS:
PRIMARY SIGNAL
SECONDARY SIGNAL
FEEDBACK SIGNAL
† SEE BACK-DATING, APPENDIX I
REFERENCE DESIGNATIONS
A1: C1-14 CR1-2 Q1-15 R1-3, 5-17 19-44 A1A1
CHASSIS: J2,3 R1-5, 10-13 S3 XA1
NOT ASSIGNED: A1R4, A1R18, A1R25
COPYRIGHT 1968 BY HEWLETT-PACKARD CO.
432A THERMISTOR BRIDGE A1 SCHEMATIC
1

Figure 4-3. Model 432A RF Bridge Talking Schematic (Sheet 1 of 2)



STOR BRIDGE ASSEMBLY (00432-60024)
Q9, 10
+7V
+6V
Q11
-11V
R41 31.6K
+7V
R36 3.16K
TO BASE Q12B
R23
+4V
-13V
R37 3.16K
C8 0.22
RF +10 dBM TO -30 dBM
+7V (SEE NOTE 1)
R3 31.6K
Q4 Q5 +5.4V
-10.2V
R40 31.6K
-13V
R38 3.16K
TO BASE Q7B
A1R32
R9 178K
R39 3.16K
R16 1K
+2.6V
Q7A
Q7B
R11 511
C3 0.01
OFFSET ADJ
R12 100
CW
C2 0.01
Q7,8 DIFFERENTIAL AMPLIFIER
-13V
A2 METER LOGIC ASSEMBLY
AUTO-ZERO FEEDBACK
XA1
Q1
S4 FINE ZERO
-13V
A3S1
RANGE
mW-dBm
.01/-20
.03/-15
.1/-10
.3/-5
1/0
3/+5
10/+10
COARSE ZERO
-13V
+7V
R35 10K
+12V
CR1 21.5V
V COMPENSATION BRIDGE SIGNAL TO A2 ASSY
J3
VCOMP
PRIMARY
SECONDARY SIGNAL
FEEDBACK SIGNAL
NOT ASSIGNED: A1R4, A1R18
COPYRIGHT
432A THERMISTOR BRIDGE (1) SCHEMATIC
1
3
5
6
7
9

Thermistor Bridge

Consists of the thermistor, R29, R27, and R5 (R4 and R5 for 200-ohm thermistors). The MOUNT RESISTANCE switch adjusts the bridge circuit for 100-ohm or 200-ohm thermistors. The bridge output (V_{RF}) is taken from S3 and is applied to Q12A/B. As RF input power increases, the thermistor resistance decreases and requires less feedback current from Q11. Accordingly, V_{RF} decreases with increasing RF input.

Differential Amplifier

Q9 and Q10 amplify the voltage difference between the collectors of Q12 A/B.

Bridge Current Source

Q15 & Q11 supply bias current to the bridge circuit to maintain correct thermistor resistance. RF power to the thermistor decreases its resistance; Q11 then supplies less current to compensate. Q15 provides current gain to drive Q11.

Thermistor Bridge

Consists of the thermistor, R16, R14 and R3 (R3 and R2 for 200-ohm thermistors). The MOUNT RESISTANCE switch adjusts the bridge circuit for 100-ohm or 200-ohm thermistors. The bridge output (V_{COMP}) is taken from S3 and is applied to Q7A/B. COARSE ZERO variable resistor R1 which is in parallel with R14 and R16 is a bridge-balance adjustment. As the ambient temperature changes, the thermistor resistance changes, thus, requiring more or less feedback current from Q6. The result: V_{COMP} changes to compensate for variations in ambient temperature.

Differential Amplifier

Q12A/B amplify voltage differences between the two sides of the bridge. Q13 is a high-impedance current source for high amplifier common-mode rejection. R15 is a balance potentiometer to equalize the base voltages of Q12 A and B. C8/C9/R28, and C7/R24 are for roll-off above about 100 Hz. C6 and C11 filter out RF interference. The guard rings around the base connections of Q12 A & Q12B protect the base circuits from leakage current across the board.

Bridge Current Source

Q14 and Q6 supply bias current to the bridge circuit to maintain correct thermistor resistance. Ambient temperature increases will decrease the thermistor resistance; Q6 then supplies less current to compensate.

Auto Zero Adj

R43 adjusts auto zero circuitry so instrument zeros precisely on zero.

Differential Amplifier

Q4 and Q5 amplify the voltage difference between the collectors of Q7 A and B.

Differential Amplifier

Q1 and Q2 amplify any current due to meter current across R73, R74 & R75. With zero RF power to the thermistor, any such voltage is an error signal. The output is from Q2 to the relay A1A1K1.

Differential Amplifier

Q7 A & B amplifier voltage differences between the two sides of the bridge. Q8 is a high-impedance current source for high amplifier common-mode rejection. R12 is a balance potentiometer to equalize the base voltages of Q7 A & B. C4/C5/R15, and C3/R11 are for roll-off above about 100 Hz. C2 and C10 filter out RF interference. The guard rings around the base connectors of Q7 A & B protect the base circuits from leakage current across the board.

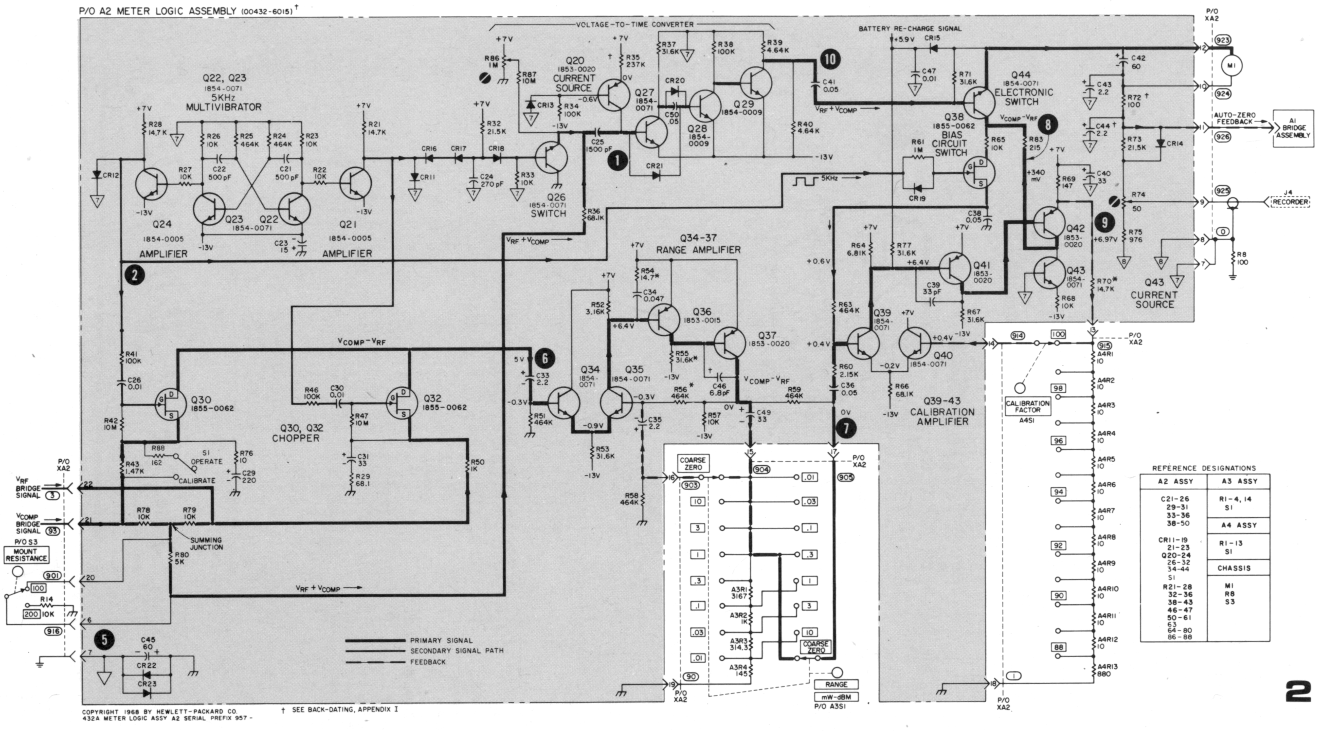
Switch

Q3 is normally off; it saturates when RANGE switch is set to COARSE ZERO. This sets the gate voltage of FET A1A1Q1 at about —6.5 v, which is halfway between its limits.

FET Memory Circuit

Relay K1 closes for fine and coarse zeroing. C1 charges to the error signal voltage at the collector of Q2. When K1 opens, C1 holds the charge. FET Q1 is a source follower and has high input impedance. The output voltage drives the compensation bridge so that the meter reads zero when the RF input is zero. R1 and CR1 protect the FET from static charge.

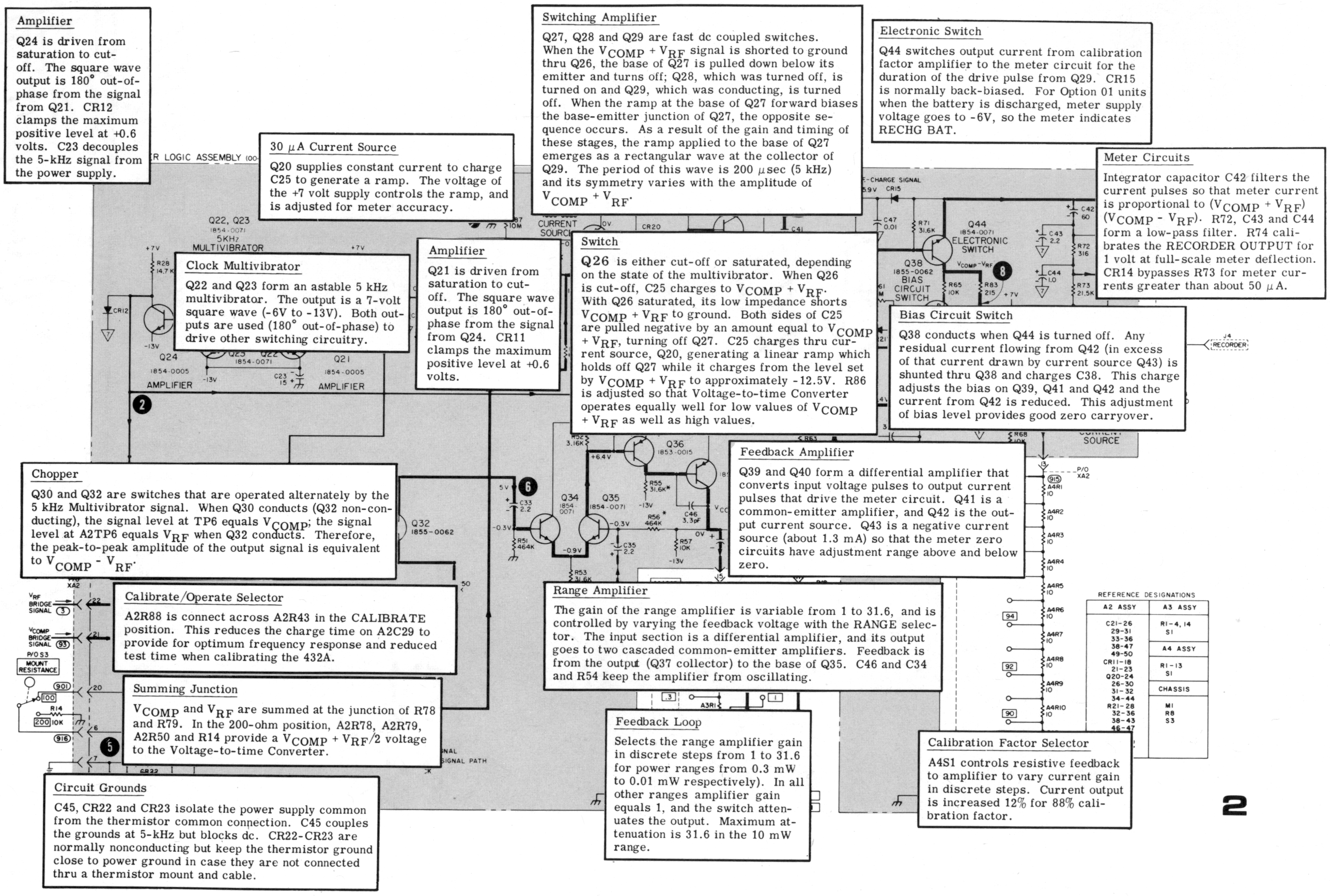
Figure 4-3. Model 432A RF Bridge Talking Schematic (Sheet 2 of 2)


P/O A2 METER LOGIC ASSEMBLY (00432-6015)†
VOLTAGE-TO-TIME CONVERTER
BATTERY RE-CHARGE SIGNAL
Q22, Q23
1854-0071
5KHz
MULTIVIBRATOR
Q24
1854-0005
AMPLIFIER
Q21
1854-0005
AMPLIFIER
Q20
1853-0020
CURRENT
SOURCE
Q27
1854-0071
Q28
1854-0009
Q29
1854-0009
Q26
1854-0071
SWITCH
Q44
1854-0071
ELECTRONIC
SWITCH
Q38
1855-0062
BIAS
CIRCUIT
SWITCH
Q42
1853-0020
Q41
1853-0020
Q43
1854-0071
Q43
CURRENT
SOURCE
Q34-37
RANGE AMPLIFIER
Q34
1854-0071
Q35
1854-0071
Q36
1853-0015
Q37
1853-0020
Q39
1854-0071
Q40
1854-0071
Q39-43
CALIBRATION
AMPLIFIER
Q30
1855-0062
Q32
1855-0062
Q30, Q32
CHOPPER
VCOMP-VRF
VRF+VCOMP
5KHz
VRF BRIDGE SIGNAL
VCOMP BRIDGE SIGNAL
P/O S3
MOUNT RESISTANCE
S1
OPERATE
CALIBRATE
SUMMING JUNCTION
COARSE ZERO
RANGE
mW-dBM
P/O A3S1
CALIBRATION FACTOR
A4S1
AUTO-ZERO FEEDBACK
A1 BRIDGE ASSEMBLY
J4 RECORDER
M1
P/O XA2
PRIMARY SIGNAL
SECONDARY SIGNAL PATH
FEEDBACK
COPYRIGHT 1968 BY HEWLETT-PACKARD CO.
432A METER LOGIC ASSY A2 SERIAL PREFIX 957-
† SEE BACK-DATING, APPENDIX I
1
2
5
6
7
8
9
10
2

REFERENCE DESIGNATIONS

A2 ASSY	A3 ASSY
C21-26 29-31 33-36 38-50 CR11-19 21-23 Q20-24 26-32 34-44 S1 R21-28 32-36 38-43 46-47 50-61 63 64-80 86-88	R1-4, 14 S1 **A4 ASSY** R1-13 S1 **CHASSIS** M1 R8 S3

Figure 4-4. Model 432A Meter Logic Talking Schematic (Sheet 1 of 2)


R LOGIC ASSEMBLY (00
Q22, Q23
1854-0071
5KHz
MULTIVIBRATOR
+7V
R28
14.7K
CR12
-13V
Q24
1854-0005
AMPLIFIER
Q21
1854-0005
AMPLIFIER
C23
15
2
10M
CURRENT
SOURCE
CR20
C41
E-CHARGE SIGNAL
5.9V
CR15
C47
0.01
R71
31.6K
Q44
1854-0071
ELECTRONIC
SWITCH
Q38
1855-0062
BIAS
CIRCUIT
SWITCH
$V_{COMP}-V_{RF}$
8
R65
10K
R83
215
+7V
C42
60
C43
2.2
R72
316
C44
1.0
R73
21.5K
J4
RECORDER
R52
3.16K
+6.4V
Q36
1853-0015
R55
31.6K*
Q34
1854-0071
Q35
1854-0071
-13V
R56
464K
C46
3.3pF
-0.3V
OV
R57
10K
-13V
C35
2.2
-0.9V
R53
31.6K
5V
6
C33
2.2
R51
464K
Q32
1855-0062
R68
SOURCE
P/O
XA2
915
A4R1 10
A4R2 10
A4R3 10
A4R4 10
A4R5 10
A4R6 10
A4R7 10
A4R8 10
A4R9 10
A4R10 10
94
92
90
.3
1
A3R1
V_{RF} BRIDGE SIGNAL 3
V_{COMP} BRIDGE SIGNAL 93
P/O S3
MOUNT RESISTANCE
901
100
R14
200 10K
916
22
21
20
6
7
5
50
CR22
SIGNAL PATH
2

REFERENCE DESIGNATIONS

A2 ASSY	A3 ASSY
C21-26 29-31 33-36 38-47 49-50 CR11-18 21-23 Q20-24 26-30 31-32 34-44 R21-28 32-36 38-43 46-47	R1-4, 14 S1
	A4 ASSY
	R1-13 S1
	CHASSIS
	M1 R8 S3

Amplifier

Q24 is driven from saturation to cut-off. The square wave output is 180° out-of-phase from the signal from Q21. CR12 clamps the maximum positive level at +0.6 volts. C23 decouples the 5-kHz signal from the power supply.

30 μA Current Source

Q20 supplies constant current to charge C25 to generate a ramp. The voltage of the +7 volt supply controls the ramp, and is adjusted for meter accuracy.

Switching Amplifier

Q27, Q28 and Q29 are fast dc coupled switches. When the $V_{COMP} + V_{RF}$ signal is shorted to ground thru Q26, the base of Q27 is pulled down below its emitter and turns off; Q28, which was turned off, is turned on and Q29, which was conducting, is turned off. When the ramp at the base of Q27 forward biases the base-emitter junction of Q27, the opposite sequence occurs. As a result of the gain and timing of these stages, the ramp applied to the base of Q27 emerges as a rectangular wave at the collector of Q29. The period of this wave is 200 μsec (5 kHz) and its symmetry varies with the amplitude of $V_{COMP} + V_{RF}$.

Electronic Switch

Q44 switches output current from calibration factor amplifier to the meter circuit for the duration of the drive pulse from Q29. CR15 is normally back-biased. For Option 01 units when the battery is discharged, meter supply voltage goes to -6V, so the meter indicates RECHG BAT.

Meter Circuits

Integrator capacitor C42 filters the current pulses so that meter current is proportional to $(V_{COMP} + V_{RF})$ $(V_{COMP} - V_{RF})$. R72, C43 and C44 form a low-pass filter. R74 calibrates the RECORDER OUTPUT for 1 volt at full-scale meter deflection. CR14 bypasses R73 for meter currents greater than about 50 μA.

Clock Multivibrator

Q22 and Q23 form an astable 5 kHz multivibrator. The output is a 7-volt square wave (-6V to -13V). Both outputs are used (180° out-of-phase) to drive other switching circuitry.

Amplifier

Q21 is driven from saturation to cut-off. The square wave output is 180° out-of-phase from the signal from Q24. CR11 clamps the maximum positive level at +0.6 volts.

Switch

Q26 is either cut-off or saturated, depending on the state of the multivibrator. When Q26 is cut-off, C25 charges to $V_{COMP} + V_{RF}$. With Q26 saturated, its low impedance shorts $V_{COMP} + V_{RF}$ to ground. Both sides of C25 are pulled negative by an amount equal to $V_{COMP} + V_{RF}$, turning off Q27. C25 charges thru current source, Q20, generating a linear ramp which holds off Q27 while it charges from the level set by $V_{COMP} + V_{RF}$ to approximately -12.5V. R86 is adjusted so that Voltage-to-time Converter operates equally well for low values of $V_{COMP} + V_{RF}$ as well as high values.

Bias Circuit Switch

Q38 conducts when Q44 is turned off. Any residual current flowing from Q42 (in excess of that current drawn by current source Q43) is shunted thru Q38 and charges C38. This charge adjusts the bias on Q39, Q41 and Q42 and the current from Q42 is reduced. This adjustment of bias level provides good zero carryover.

Chopper

Q30 and Q32 are switches that are operated alternately by the 5 kHz Multivibrator signal. When Q30 conducts (Q32 non-conducting), the signal level at TP6 equals V_{COMP}; the signal level at A2TP6 equals V_{RF} when Q32 conducts. Therefore, the peak-to-peak amplitude of the output signal is equivalent to $V_{COMP} - V_{RF}$.

Feedback Amplifier

Q39 and Q40 form a differential amplifier that converts input voltage pulses to output current pulses that drive the meter circuit. Q41 is a common-emitter amplifier, and Q42 is the output current source. Q43 is a negative current source (about 1.3 mA) so that the meter zero circuits have adjustment range above and below zero.

Calibrate/Operate Selector

A2R88 is connect across A2R43 in the CALIBRATE position. This reduces the charge time on A2C29 to provide for optimum frequency response and reduced test time when calibrating the 432A.

Range Amplifier

The gain of the range amplifier is variable from 1 to 31.6, and is controlled by varying the feedback voltage with the RANGE selector. The input section is a differential amplifier, and its output goes to two cascaded common-emitter amplifiers. Feedback is from the output (Q37 collector) to the base of Q35. C46 and C34 and R54 keep the amplifier from oscillating.

Summing Junction

V_{COMP} and V_{RF} are summed at the junction of R78 and R79. In the 200-ohm position, A2R78, A2R79, A2R50 and R14 provide a $V_{COMP} + V_{RF}/2$ voltage to the Voltage-to-time Converter.

Feedback Loop

Selects the range amplifier gain in discrete steps from 1 to 31.6 for power ranges from 0.3 mW to 0.01 mW respectively). In all other ranges amplifier gain equals 1, and the switch attenuates the output. Maximum attenuation is 31.6 in the 10 mW range.

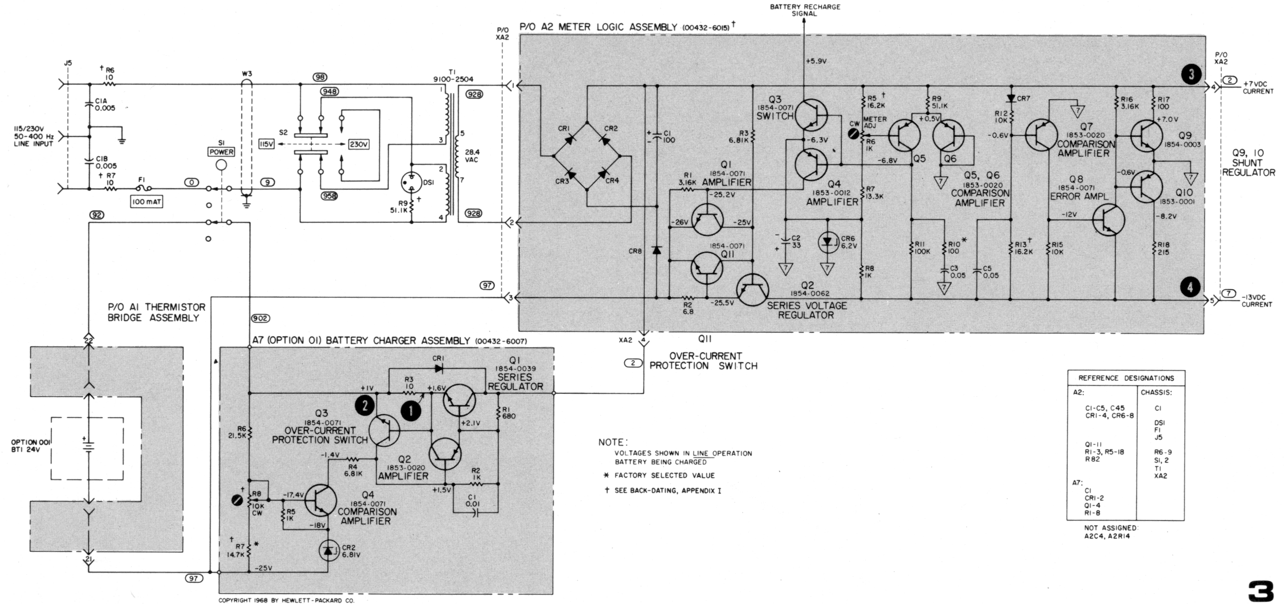
Calibration Factor Selector

A4S1 controls resistive feedback to amplifier to vary current gain in discrete steps. Current output is increased 12% for 88% calibration factor.

Circuit Grounds

C45, CR22 and CR23 isolate the power supply common from the thermistor common connection. C45 couples the grounds at 5-kHz but blocks dc. CR22-CR23 are normally nonconducting but keep the thermistor ground close to power ground in case they are not connected thru a thermistor mount and cable.

Figure 4-4. Model 432A Meter Logic Talking Schematic (Sheet 2 of 2)


J5
115/230V
50-400 Hz
LINE INPUT
† R6
10
C1A
0.005
C1B
0.005
† R7
10
F1
100 mAT
0
S1
POWER
W3
9
92
98
948
958
S2
115V
230V
T1
9100-2504
928
28.4
VAC
DS1
R9
51.1K
P/O
XA2
97
902
P/O A1 THERMISTOR
BRIDGE ASSEMBLY
22
21
OPTION 001
BT1 24V
A7 (OPTION 01) BATTERY CHARGER ASSEMBLY (00432-6007)
CR1
Q1
1854-0039
SERIES
REGULATOR
R3
10
+1V
+1.6V
+2.1V
R1
680
Q3
1854-0071
OVER-CURRENT
PROTECTION SWITCH
R6
21.5K
-1.4V
R4
6.81K
Q2
1853-0020
AMPLIFIER
R2
1K
+1.5V
C1
0.01
R8
10K
CW
-17.4V
R5
1K
Q4
1854-0071
COMPARISON
AMPLIFIER
-18V
R7
14.7K
CR2
6.81V
-25V
P/O A2 METER LOGIC ASSEMBLY (00432-6015) †
BATTERY RECHARGE
SIGNAL
+5.9V
CR1
CR2
CR3
CR4
C1
100
R3
6.81K
Q3
1854-0071
SWITCH
-6.3V
R1
3.16K
Q1
1854-0071
AMPLIFIER
-25.2V
-26V
-25V
CR8
1854-0071
Q11
R2
6.8
-25.5V
Q2
1854-0062
SERIES VOLTAGE
REGULATOR
Q4
1853-0012
AMPLIFIER
C2
33
CR6
6.2V
R5 †
16.2K
METER
ADJ
CW
R6
1K
R7
13.3K
R8
1K
R9
51.1K
+0.5V
-6.8V
Q5
Q6
Q5, Q6
1853-0020
COMPARISON
AMPLIFIER
R11
100K
R10 *
100
C3
0.05
C5
0.05
CR7
R12
10K
-0.6V
R13 †
16.2K
Q7
1853-0020
COMPARISON
AMPLIFIER
Q8
1854-0071
ERROR AMPL
-12V
R15
10K
R16
3.16K
R17
100
+7.0V
Q9
1854-0003
-0.6V
Q10
1853-0001
-8.2V
R18
215
Q9, 10
SHUNT
REGULATOR
2
+7VDC
CURRENT
7
-13VDC
CURRENT
XA2
Q11
OVER-CURRENT
PROTECTION SWITCH
1
2
3
4
3

NOTE:
VOLTAGES SHOWN IN LINE OPERATION
BATTERY BEING CHARGED
* FACTORY SELECTED VALUE
† SEE BACK-DATING, APPENDIX I

REFERENCE DESIGNATIONS	
A2:	CHASSIS:
C1-C5, C45 CR1-4, CR6-8	C1 DS1 F1 J5
Q1-11 R1-3, R5-18 R82	R6-9 S1, 2 T1 XA2
A7: C1 CR1-2 Q1-4 R1-8	

NOT ASSIGNED:
A2C4, A2R14

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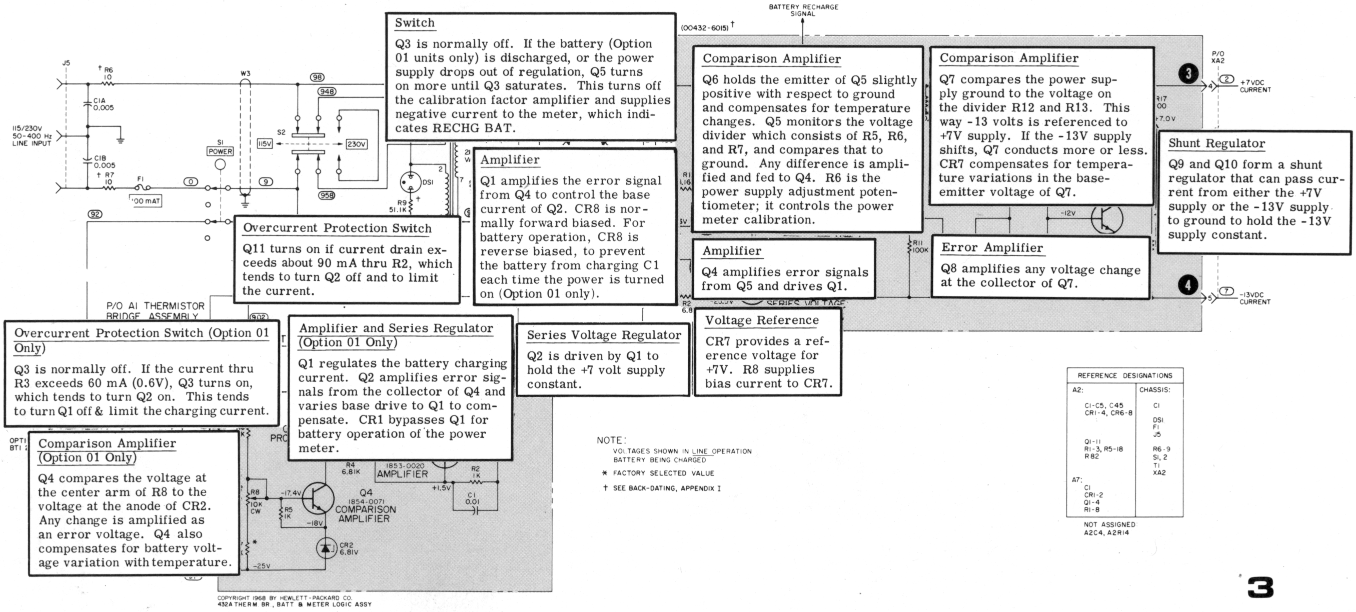
432A THERM BR., BATT & METER LOGIC ASSY

Figure 4-5. Model 432A Power Supply Talking Schematic (Sheet 1 of 2)


BATTERY RECHARGE SIGNAL
(00432-6015)†
J5
R6 10
C1A 0.005
115/230V 50-400 Hz LINE INPUT
C1B 0.005
† R7 10
F1
100 mAT
S1 POWER
W3
S2
115V
230V
DS1
R9 51.1K
P/O A1 THERMISTOR BRIDGE ASSEMBLY
R4 6.81K
1853-0020 AMPLIFIER
R2 1K
C1 0.01
Q4 1854-0071 COMPARISON AMPLIFIER
R8 10K CW
R5 1K
-17.4V
-18V
+1.5V
CR2 6.81V
-25V
R11 100K
R2 6.8
-12V
P/O XA2
+7VDC CURRENT
-13VDC CURRENT
+7.0V
3
4
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432A THERM BR, BATT & METER LOGIC ASSY

Switch

Q3 is normally off. If the battery (Option 01 units only) is discharged, or the power supply drops out of regulation, Q5 turns on more until Q3 saturates. This turns off the calibration factor amplifier and supplies negative current to the meter, which indicates RECHG BAT.

Comparison Amplifier

Q6 holds the emitter of Q5 slightly positive with respect to ground and compensates for temperature changes. Q5 monitors the voltage divider which consists of R5, R6, and R7, and compares that to ground. Any difference is amplified and fed to Q4. R6 is the power supply adjustment potentiometer; it controls the power meter calibration.

Comparison Amplifier

Q7 compares the power supply ground to the voltage on the divider R12 and R13. This way -13 volts is referenced to +7V supply. If the -13V supply shifts, Q7 conducts more or less. CR7 compensates for temperature variations in the base-emitter voltage of Q7.

Shunt Regulator

Q9 and Q10 form a shunt regulator that can pass current from either the +7V supply or the -13V supply to ground to hold the -13V supply constant.

Amplifier

Q1 amplifies the error signal from Q4 to control the base current of Q2. CR8 is normally forward biased. For battery operation, CR8 is reverse biased, to prevent the battery from charging C1 each time the power is turned on (Option 01 only).

Overcurrent Protection Switch

Q11 turns on if current drain exceeds about 90 mA thru R2, which tends to turn Q2 off and to limit the current.

Amplifier

Q4 amplifies error signals from Q5 and drives Q1.

Error Amplifier

Q8 amplifies any voltage change at the collector of Q7.

Overcurrent Protection Switch (Option 01 Only)

Q3 is normally off. If the current thru R3 exceeds 60 mA (0.6V), Q3 turns on, which tends to turn Q2 on. This tends to turn Q1 off & limit the charging current.

Amplifier and Series Regulator (Option 01 Only)

Q1 regulates the battery charging current. Q2 amplifies error signals from the collector of Q4 and varies base drive to Q1 to compensate. CR1 bypasses Q1 for battery operation of the power meter.

Series Voltage Regulator

Q2 is driven by Q1 to hold the +7 volt supply constant.

Voltage Reference

CR7 provides a reference voltage for +7V. R8 supplies bias current to CR7.

Comparison Amplifier (Option 01 Only)

Q4 compares the voltage at the center arm of R8 to the voltage at the anode of CR2. Any change is amplified as an error voltage. Q4 also compensates for battery voltage variation with temperature.

NOTE:
VOLTAGES SHOWN IN LINE OPERATION BATTERY BEING CHARGED
* FACTORY SELECTED VALUE
† SEE BACK-DATING, APPENDIX I

REFERENCE DESIGNATIONS	
A2:	CHASSIS:
C1-C5, C45 CR1-4, CR6-8	C1
	DS1 F1 J5
Q1-11 R1-3, R5-18 R82	R6-9 S1, 2 T1 XA2
A7: C1 CR1-2 Q1-4 R1-8	

NOT ASSIGNED:
A2C4, A2R14

Figure 4-5. Model 432A Power Supply Talking Schematic (Sheet 2 of 2)

Table 5-1. Recommended Test Equipment

Instrument Type	Critical Specifications	Recommended Model
Power Meter Calibrator	Range: 0.1 to 10 mW Accuracy: .1 to 10 mW ranges: 0.2% .01 and .03 mW ranges: 0.5%	HP 8477A
DC Digital Voltmeter	Range: 0.5 to 50 volts dc Accuracy: ±0.05% Input Impedance: 10 megohms, floating Resolution: 4 digits	HP 3440A with 3443A Plug-in Unit
Storage Oscilloscope	Variable Persistence Display Bandwidth: dc to 5 MHz Input Impedance: 1 megohm Sensitivity: 5 mV/division	HP 141A with 1405A and 1420A Plug-in Units
Vertical Plug-in	Bandwidth: 400 kHz Input Impedance: 1 megohm Sensitivity: 1 mV/division	HP 1401A
Cable Assembly (2 required)	RG 58C/U coaxial cable with 2 each BNC male connectors	HP 10503A
Test Lead	Insulated cable terminated with dual banana plug and test clips	HP 11001A
Cable Assembly	Shielded cable with one each BNC and dual banana plug connectors	HP 11000A
Thermistor Mount	Operating Resistance: 100 ohm or 200 ohms	HP 478, 8478
Filter Network		See Figure 5-2
Oscilloscope Probes (2)	Division Ratio: 10:1 ±2% Bandwidth: dc to 30 MHz Rise Time: 5 nsec	HP 10001A
Differential Voltmeter	Accuracy: ±0.005% of reading +0.0004% of range ± 1 μV	HP 740B
Resistor (2)	10K 1%, 1/8 watt	0757-0442

SECTION V

MAINTENANCE

5-1. INTRODUCTION.

5-2. This section provides information for performance testing, adjusting, troubleshooting and repairing the 432A Power Meter. Performance tests allow the instrument to be checked for conformance to specifications. If performance is not within specifications, adjust or troubleshoot the instrument.

5-3. CONTENT.

5-4. PERFORMANCE TESTS.

5-5. The procedures test power meter performance for incoming inspection, periodic evaluation, calibration and troubleshooting. Specifications in Table 1-1 are the performance standards. If the power meter fails to meet any of the performance test specifications, refer to the troubleshooting diagrams.

5-6. ADJUSTMENTS.

5-7. Procedures describe the adjustments necessary to calibrate the power meter. Adjust the power meter only when it is determined that the meter is out of adjustment and not malfunctioning due to a circuit failure.

5-8. To avoid errors due to possible ground loop currents, isolate the power meter from ground used for other auxiliary equipment. A power plug adapter that removes the ground connection at the line outlet can be used to isolate the power meter.

5-9. Several circuit components are factory-selected to meet specific circuit requirements. The factory selected parts are indicated on the schematic diagrams.

5-10. TEST EQUIPMENT.

5-11. Instruments and accessories required for adjusting and testing the power meter are listed and briefly described in Table 5-1. Instruments used to maintain the instrument must meet or exceed the specifications given.

5-12. SERVICE INFORMATION.

5-13. Service information in the form of troubleshooting, waveforms, schematics and component locations are given in Section VII. Also, an overall system block diagram is included which contains keyed numbers corresponding to the test points.

5-14. 432A PERFORMANCE TESTS WITH 8477A CALIBRATOR

5-15. INITIAL SET-UP.

a. Connect the 8477A outputs to the 432A inputs as shown in Figure 5-1. Use appropriate test equipment as listed in Table 5-1.

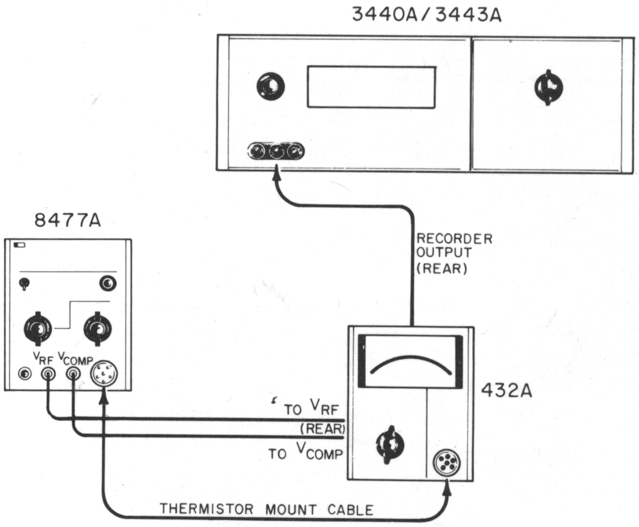

Figure 5-1. Check and Adjustment Test Set-Up

b. If necessary, mechanically zero the meter movement as follows:

(1) With instrument turned off, rotate meter adjustment screw clockwise until pointer approaches zero mark from the left.

(2) Continue rotating clockwise until pointer coincides with zero mark. If pointer overshoots, continue rotating adjustment screw clockwise until pointer once again approaches zero mark from the left.

(3) Rotate adjustment screw about three degrees counterclockwise to disengage screw adjustment from meter suspension.

5-16. METER ACCURACY TEST.

a. Set the 8477A Calibrator controls as follows:

POWER (MW)	0.01 mW
FUNCTION	200Ω
ZERO/TEST	ZERO

b. Set the 432A controls as follows:

A2S1 (on Meter Logic Assy)	CALIBRATE
MOUNT RESISTANCE	200Ω
RANGE	0.1 mW
POWER	ON
CALIBRATION FACTOR	100%

c. Adjust 8477A ZERO knob for 0 volts ±2 mV indication on the DVM.

Table 5-2. Meter Accuracy Test

432A Range (mW)	8477A Range (mW)	Digital Voltmeter Indication (millivolts ±10 mV)	Indication (Full scale ±1/2 Div.)
.01	.01	1000	1
.03	.03	948.8	3
.1	.1	1000	1
.3	.3	948.8	3
1	1	1000	1
3	3	948.8	3
10	10	1000	1

d. Set the 8477A controls as follows:

POWER (MW) . . . . 0.01 mW
ZERO/TEST . . . . TEST

e. The digital voltmeter should indicate 1000 ±10 millivolts.

f. The 432A meter should indicate full scale ±1/2 division.

g. Repeat steps d through f for each of the other ranges. Set the power meter range selector to the position indicated in Column 1 of Table 5-2 and set the 8477A meter reading selector to the corresponding position indicated in Column 2 of Table 5-2. In each case, the meter indications should correspond to those shown in Table 5-2, Columns 3 and 4.

5-17. CALIBRATION FACTOR TEST.

a. Set 432A controls as follows:

A2S1 (on Meter Logic Assy) . . . . . CALIBRATE
RANGE . . . . 0.1 mW
CAL FACTOR 88%
MOUNT RESISTANCE 200Ω

b. Set 8477A controls as follows:

FUNCTION 200Ω
ZERO/TEST Switch . . . . TEST
POWER (mW) . . . . 0.1 mW

c. Set 8477A ZERO control so that the digital voltmeter reads 1000 ±2 mV.

d. Set the calibration factor selector to 89%.

e. The digital voltmeter should indicate 989 ±10 millivolts.

f. Repeat steps d and e for each position of the CALIBRATION FACTOR selector. In each case, the digital voltmeter should indicate the voltage shown in the second column of Table 5-3 for the CALIBRATION FACTOR shown in the first column.

Table 5-3. Calibration Factor Test

Calibration Factor Selector Setting (%)	Digital Voltmeter Indication (mV)
88	1000 ±2
89	989 ±10
90	978 ±10
91	967 ±10
92	957 ±10
93	946 ±10
94	935 ±10
95	926 ±10
96	916 ±10
97	907 ±10
98	897 ±10
99	889 ±10
100	880 ±10

5-18. METER LINEARITY CHECK.

a. Set the 8477A POWER (MW) selector to 1 mW and FUNCTION to 200Ω, ZERO/TEST switch to TEST.

b. Set the 432A RANGE selector to 3 mW, MOUNT RESISTANCE to 200Ω.

c. The 432A meter should indicate 1 mW ±1/2 division.

d. Set the 8477A POWER (MW) selector to 2 mW.

e. The 432A meter should indicate 2 mW ±1/2 division.

f. Set the 8477A POWER (MW) selector to 3 mW.

g. The 432A meter should indicate 3 mW ±1/2 division.

h. Set A2S1 to OPERATE.

5-19. ZERO CARRYOVER TEST.

a. Disconnect the 432A from the 8477A.

b. Turn the 432A power OFF and connect the thermistor mount cable to a thermistor mount.

c. Set the 432A Power Meter MOUNT RESISTANCE selector to the resistance shown on the thermistor mount.

d. Turn ON the 432A power.

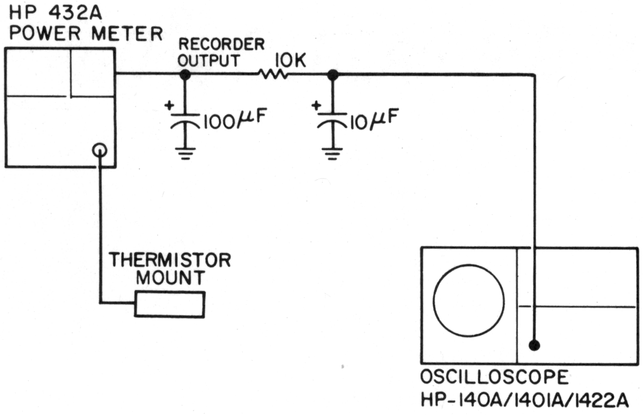

Figure 5-2. Zero Carryover Test Setup

e. Connect 141A through filtering network to rear of 432A as shown in Figure 5-2. Set 141A controls as follows:

INPUT . . . . DC
SENSITIVITY . . . . 1 mV/cm
SWEEP TIME . . . . 2 sec/cm
TRIGGER LEVEL . . . . . max clockwise (free run)

f. Zero the 432A as follows:

(1) Set the RANGE selector maximum cw to COARSE ZERO.

(2) Set the COARSE ZERO screwdriver adjust so that the meter indicates zero.

(3) Set 432A RANGE switch to .01 mW. Depress the FINE ZERO switch. The meter indication should go to zero without overshoot.

g. Rotate the RANGE switch clockwise, one step at a time, while the oscilloscope is sweeping. On each 432A range, the scope trace should be within .01 mW division (±5 mW) from where it was on the .01 mW range.

5-20. FINE ZERO RANGE CHECK.

a. Set the 432A RANGE selector to 0.3 mW. Leave the thermistor mount connected to the cable and the MOUNT RESISTANCE selector set to correspond to the resistance of the mount used.

b. Depress the FINE ZERO switch.

c. Slowly turn the COARSE ZERO screwdriver adjustment counterclockwise until the meter will no longer zero. The FINE zero circuit is at one end of its range.

d. Release FINE ZERO.

e. Set the COARSE ZERO screwdriver adjustment so that the meter indicates full scale on the 0-3 scale (0.3 mW range).

f. Depress FINE ZERO switch (the fine zero circuit is at the other end of its range). Meter should indicate below 2 on the 0-3 scale. Record the indication.

g. Release FINE ZERO.

h. Rotate RANGE switch to COARSE ZERO position. The fine zero circuit is now in the center of its range. The meter reading should be 1.5 + 1/2 reading of step f, ±0.1 div. on the 0-3 scale .

5-21. 432A CALIBRATION WITHOUT 8477A CALIBRATOR.

5-22. The 432A Power Meter can be calibrated without an 8477A Calibrator using a method similar to the precision power method outlined in Paragraph 3-27.

5-23. A major difference between the two measurements is that external power need not be applied when calibrating the instrument. Normally, in a stable environment, the V_{COMP} output voltage remains constant, not being affected by external RF power; only the V_{RF} output varies during power measurement. Since the power that the meter indicates is proportional to V_{COMP} and V_{RF}, we can cause the meter to indicate a power also by holding V_{RF} constant and varying V_{COMP}. This is easily done on the 432A by turning the COARSE ZERO control. Two calibration procedures are given below. Full scale readings are not possible on the 10 mW RANGE. Full scale readings are possible on the 3 mW RANGE depending on the mount characteristics.

5-24. CALIBRATION PROCEDURE 1.

a. Connect thermistor mount to power meter; let instrument warm up for at least ten minutes.

b. Select range which instrument is to be calibrated on.

Note

Ranges below 0.3 mW require a precise differential voltmeter capable of resolving 1 μV. The HP 740B DC Standard/Δ Voltmeter, which has an accuracy of ±(0.005% of reading + 0.0004% of range ±1 μV) is recommended. A digital voltmeter is adequate for the 1.0 mW and higher ranges.

c. Connect Differential Voltmeter (or DVM differentially) between the V_{COMP} and V_{RF} output jacks on the rear panel. See Figure 3-3 for location of V_{RF} and V_{COMP} outputs.

d. While pressing the FINE ZERO switch, measure and record V_0. (V_0 is the difference of the bridge voltages with no power applied.)

e. Turn COARSE ZERO control (on front panel) clockwise to a convenient power, e.g., 9 on the 0 to 10 scale or 2 on the 0 to 3 scale.

f. Differentially measure and record V_1. V_1 is the difference voltage between V_{COMP} and V_{RF} with power applied.

NOTES

INSTRUMENT SERIAL NO. ____________

DATE ______________________________

TABLE 5-4. PERFORMANCE TEST CARD

Data in this test card corresponds to Performance Tests in Paragraphs 5-16 through 5-20.

TABLE 5-4. PERFORMANCE TEST CARD

Para. Ref.	Test		Measurement Unit	Min.	Actual	Max.
5-16	METER ACCURACY					
e	0.01 mW applied; measure RECORDER OUT voltage		mVdc	990	______	1010
f	Meter indicates full-scale (0-1 scale)		divisions	-1/2	______	+1/2
	Repeat on remaining 432A power ranges:					
e	Power applied: 0.03 mW		mVdc	938.8	______	958.8
f	Meter indication (0-3 scale)		divisions	-1/2	______	+1/2
e	Power applied: 0.1 mW		mVdc	990	______	1010
f	Meter indication (0-1 scale)		divisions	-1/2	______	+1/2
e	Power applied: 0.3 mW		mVdc	938.8	______	958.8
f	Meter indication (0-3 scale)		divisions	-1/2	______	+1/2
e	Power applied: 1 mW		mVdc	990	______	1010
f	Meter indication (0-1 scale)		divisions	-1/2	______	+1/2
e	Power applied: 3 mW		mVdc	938.8	______	958.8
f	Meter indication (0-3 scale)		divisions	-1/2	______	+1/2
e	Power applied: 10 mW		mVdc	990	______	1010
f	Meter indication (0-1 scale)		divisions	-1/2	______	+1/2
5-17	CALIBRATION FACTOR					
i	Calibration Factor (%)	DVM Reading (mVdc)				
	88	1000	mVdc	990	______	1010
	89	989	mVdc	979	______	999
	90	978	mVdc	968	______	988
	91	967	mVdc	957	______	977
	92	957	mVdc	947	______	967
	93	946	mVdc	936	______	956
	94	935	mVdc	925	______	945
	95	926	mVdc	916	______	936
	96	916	mVdc	906	______	926
	97	907	mVdc	897	______	917
	98	897	mVdc	887	______	907
	99	889	mVdc	879	______	899
	100	880	mVdc	870	______	890

TABLE 5-4. PERFORMANCE TEST CARD

Para. Ref.	Test	Measurement Unit	Min.	Actual	Max.
5-18	METER LINEARITY				
c	1 mW applied, 3 mW scale: meter indicates 1 mW	divisions	-1/2	_____	+1/2
e	2 mW applied, 3 mW scale: meter indicates 2 mW	divisions	-1/2	_____	+1/2
g	3 mW applied, 3 mW scale: meter indicates 3 mW	divisions	-1/2	_____	+1/2
5-19	ZERO CARRY-OVER				
d	Zero carry-over:				
	Range (mW) Scope Indication				
	.01 0 ±5 mVdc	mVdc	-5	_____	+5
	.03 0 ±5 mVdc	mVdc	-5	_____	+5
	.1 0 ±5 mVdc	mVdc	-5	_____	+5
	.3 0 ±5 mVdc	mVdc	-5	_____	+5
	1 0 ±5 mVdc	mVdc	-5	_____	+5
	3 0 ±5 mVdc	mVdc	-5	_____	+5
	10 0 ±5 mVdc	mVdc	-5	_____	+5
5-20	FINE ZERO RANGE				
f	Meter indication on 0-3 scale:	divisions	1.75	_____	2.0
g	Meter indication on 0-3 scale: 1.5 + 1/2 reading of step f, ±0.1 div.	divisions	0.1	_____	0.1

g. Measure and record V_{COMP}. Note that the V_{COMP} jack is isolated from chassis ground; measure from the center conductor of the BNC to the outer conductor.

h. Calculate the power using the following formula*:

$$P = \frac{1}{4R}\left[2\,V_{COMP}\left(V_1 - V_0\right) - V_1^{\,2}\right] \qquad (1)$$

where R is the resistance of the thermistor mount and should be identical to the setting of the MOUNT RESISTANCE switch.

i. If calculated power is different from the value that was set with the COARSE ZERO control, adjust A2R6 so that the meter reads calculated power. If the range of A2R6 is insufficient to set new power, it will be necessary to change the value of A2R70.

j. Set COARSE ZERO so that meter reads 1 on the 0 to 1 scale. Set A2R72 for 1.000V ±10 mV at the RECORDER output jack on the rear panel.

5-25. There is a simpler form of the equation that was used to calculate power in step h above. This form ignores V_0, the small voltage difference between the two bridges with no power applied. However, V_0 becomes negligible on the higher ranges, that is, 1 mV and above, and can be ignored with little decrease in accuracy. The simpler form is as follows:

$$P = \frac{1}{4R}\left(V_C - V_{RF}\right)\left(V_C + V_{RF}\right) \qquad (2)$$

5-26. CALIBRATION PROCEDURE 2.

a. Connect thermistor mount to power meter; let instrument warm up for at least ten minutes.

b. Select 1, 3 or 10 mW range.

c. Turn the COARSE ZERO control clockwise to indicate some convenient on-scale reading.

d. Measure V_{COMP} and record. Note that V_{COMP} jack is isolated from chassis ground; measure from the center conductor of the BNC to the outer conductor.

e. Measure V_{RF} and record. Follow measurement procedure in step d.

f. Measure and record $V_{COMP} - V_{RF}$. This term must be measured differentially, that is, one side of the DVM connected to V_{COMP} and the other side connected to V_{RF}. In this way the full resolution of the DVM can be used.

g. Substituting the measured values into the above formula, calculate the power.

h. If calculated power is different from the power set with the COARSE ZERO control, adjust A2R6 so that meter indicates that power. If the range of A2R6 is not great enough to set new power level, the value of A2R70 will have to be changed.

i. Adjust COARSE ZERO so that meter reads 1 on the 0 to 1 scale. Set A2R72 for 1.000V ±10 mV at the RECORDER output jack on the rear panel.

5-27. COVER REMOVAL AND REPLACEMENT.

5-28. The side covers can be removed and replaced independently of the top and bottom covers. Each side cover is held in place by four screws retained by nuts which are fastened to the side frames.

5-29. TOP COVER REMOVAL.

a. At the rear of the instrument, remove the screw that retains the cover.

b. Grasp the cover from the rear, and slide it back 1/2 inch. Then tilt forward edge of the cover upward and lift the cover from the instrument.

5-30. TOP COVER REPLACEMENT.

a. Rest the cover flat on the cast guides projecting inward near the top of each side frame.

b. Slide the cover forward, allowing its forward edge to enter the groove in the front panel.

c. Replace the cover retaining screw.

5-31. BOTTOM COVER REMOVAL.

a. Remove the retaining screw at the rear of the cover.

b. Swing the tilt stand out to free the cover.

c. Slide the cover rearward far enough to free the forward edge.

d. Tilt the forward edge of the cover upward and lift the cover from the instrument.

5-32. BOTTOM COVER REPLACEMENT.

a. Set the tilt stand out of the way of the cover.

b. Rest the bottom cover flat on the case guides projecting inward near the bottom of each side frame.

c. Slide the cover forward on the guides so that the formed portion at the rear of the cover slides over the two short projections at the rear corner of each side frame.

d. Replace the retaining screw.

---

*This formula is accurate for on-scale readings; however, with no power applied (i.e., $V_1 = V_0$) it does not solve to P = 0 because of a deleted term $+ V_0$. This term can be neglected for any on-scale reading.

5-33. ADJUSTMENT PROCEDURES.

5-34. INITIAL SETUP.

a. Remove the power meter side panels.

b. Connect the equipment as shown in Figure 5-1. Refer to Table 5-1 for equipment specifications.

5-35. MECHANICAL METER ADJUSTMENT.

a. When the meter is properly zero-set, the pointer rests over the zero mark on the meter scale when the instrument is:

(1) at normal operating temperature

(2) in its normal operating position

(3) turned off.

b. Set the pointer as follows to obtain best accuracy and mechanical stability:

(1) Turn instrument off.

(2) Rotate the meter mechanical adjustment screw clockwise until the meter is to the left of zero and moving up the scale toward zero. Stop when the pointer is exactly over the zero mark. If the pointer overshoots, repeat step 2.

(3) When the pointer is exactly on zero, rotate the adjustment screw approximately three degrees counterclockwise. This frees the adjustment screw from the meter suspension. If the pointer moves during this step, repeat steps 2 and 3.

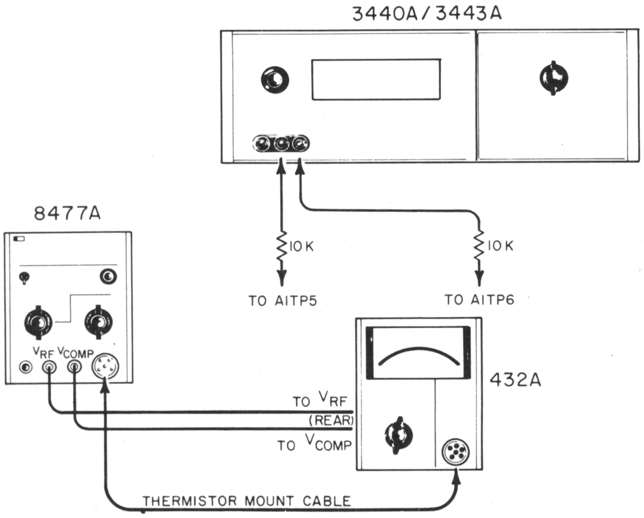

Figure 5-3. Bridge Amplifier Test

5-36. BRIDGE AMPLIFIER TESTS.

a. Connect equipment as shown in Figure 5-3.

b. Compensation Bridge.

(1) Connect 3440A/3443A between A1TP5 and A1TP6 (using 10K isolation resistors).

(2) Make the following settings:

432A

RANGE	10 mW
MOUNT RESISTANCE	200Ω

8477A

FUNCTION	SET

(3) Adjust A1R12 (OFFSET ADJUST) for 0.0 ±0.1 mVdc reading on the digital voltmeter.

(4) Change 8477A FUNCTION to CHECK. The digital VM reading should not exceed ±0.4 mVdc.

c. RF BRIDGE

(1) Connect DVM between A1TP3 and A1TP4 using 10K isolation resistors in series with the leads.

(2) Set 8477A FUNCTION to SET. Adjust A1R15 (OFFSET ADJUST) for DVM reading of 0.0 ±0.1 mVdc.

(3) Change 8477A FUNCTION to CHECK. The reading should not exceed ±0.4 mVdc.

Note

Failure of the instrument to meet the specification of steps b (4) and c (3) above indicates insufficient bridge gain. Refer to Tables 7-3 or 7-4 in the troubleshooting section.

5-37. METER AND RECORDER OUTPUT CALIBRATION.

a. Connect the DVM to the 432A RECORDER output.

b. Set 8477A controls as follows:

FUNCTION	200Ω
ZERO/TEST	ZERO
POWER	1 mW

c. Set 432A controls as follows:

A2S1 (on Meter Logic Assy)	CALIBRATE
MOUNT RES	200Ω
RANGE	1 mW
CAL FACTOR	100%

d. Adjust Zero control on 8477A for DVM indication of 0.000 ±.001V.

e. ZERO/TEST on 8477A to TEST.

f. Adjust A2R6 in 432A for 432A meter reading of 1.0 mW ±.01 mW.

g. Adjust A2R74 in 432A for DVM reading of 1.0V ±.001V.

h. Change the following settings:

432A RANGE to 10 mW
8477A POWER (mW) to 10 mW and ZERO/TEST to ZERO.

Note

> When switching 432A to 10 mW or switching from 10 mW to any other range, the meter will react slowly for a short period. This is due to time constants in the instrument and is normal.

i. Check zero and adjust as necessary.

j. Set ZERO/TEST to TEST and adjust A2R86 for DVM reading of 1.00 ±.001V.

k. Return 432A RANGE and 8477A POWER switches to 1 mW and zero as before.

l. Adjust A2R6 for DVM reading of 1.000 ±.001V.

m. Perform the adjustments of steps h through l again until 432A reads 1 ±.010V (at recorder output) on both 1 mW and 10 mW ranges.

n. Set A2S1 to OPERATE.

o. Turn to the beginning of this section; verify that the instrument meets its specifications by completing the PERFORMANCE TESTS.

5-37A. AUTO ZERO ADJUSTMENT, A1R43 †

a. Remove the right side panel.

b. Connect a mount to the 432A and adjust COARSE ZERO.

c. Switch RANGE to -20 dBm, push FINE ZERO down and adjust A1R43 for a zero indication on the front panel meter.

d. Release FINE ZERO and replace the right side panel.

5-38. BATTERY CHARGER ADJUSTMENT (OPTION 01 ONLY).

a. Remove the power meter top panel.

b. Connect 432A to ac line power and turn ON.

c. Set A7R8 fully counterclockwise for maximum battery charge rate.

d. With the digital voltmeter, measure the voltage between A7TP1 and A7TP2.

e. Adjust A7R8 for digital voltmeter reading of 0.2 to 0.4 volt (20 to 40 mA through R3) when battery is fully charged.

f. Disconnect the test equipment and power, and replace the power meter top and side panels.

5-39. BATTERY REMOVAL.

a. Remove the top cover.

b. Remove the two Phillips screws on the top rear of the battery cover.

c. Lift off the battery cover.

d. Loosen the nuts on the battery binding posts.

e. Lift out the battery.

5-40. ISOLATING TROUBLE IN TRANSISTOR CIRCUITS.

5-41. General. The following information should help determine if a transistor works. There are tests for both in-circuit and out-of-circuit transistors, which help to determine if a particular trouble is due to a faulty transistor of some other component. See Figure 5-2.

Table 5-5. Out-of-Circuit Transistor Resistance Measurements

		Connect Ohmmeter		Measure Resistance (ohms)
		Positive Lead to	Negative Lead to	
PNP Germanium	Small Signal	emitter	base*	200 - 500
		emitter	collector	10K - 100K
	Power	emitter	base*	30 - 50
		emitter	collector	several hundred
NPN Silicon	Small Signal	base	emitter	1K - 3K
		collector	emitter	very high (might read open)
	Power	base	emitter	200 - 1000
		collector	emitter	high, often greater than 1M

*To test for transistor action, add collector-base short. Measured resistance should decrease.

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† See Back-Dating, Appendix I.

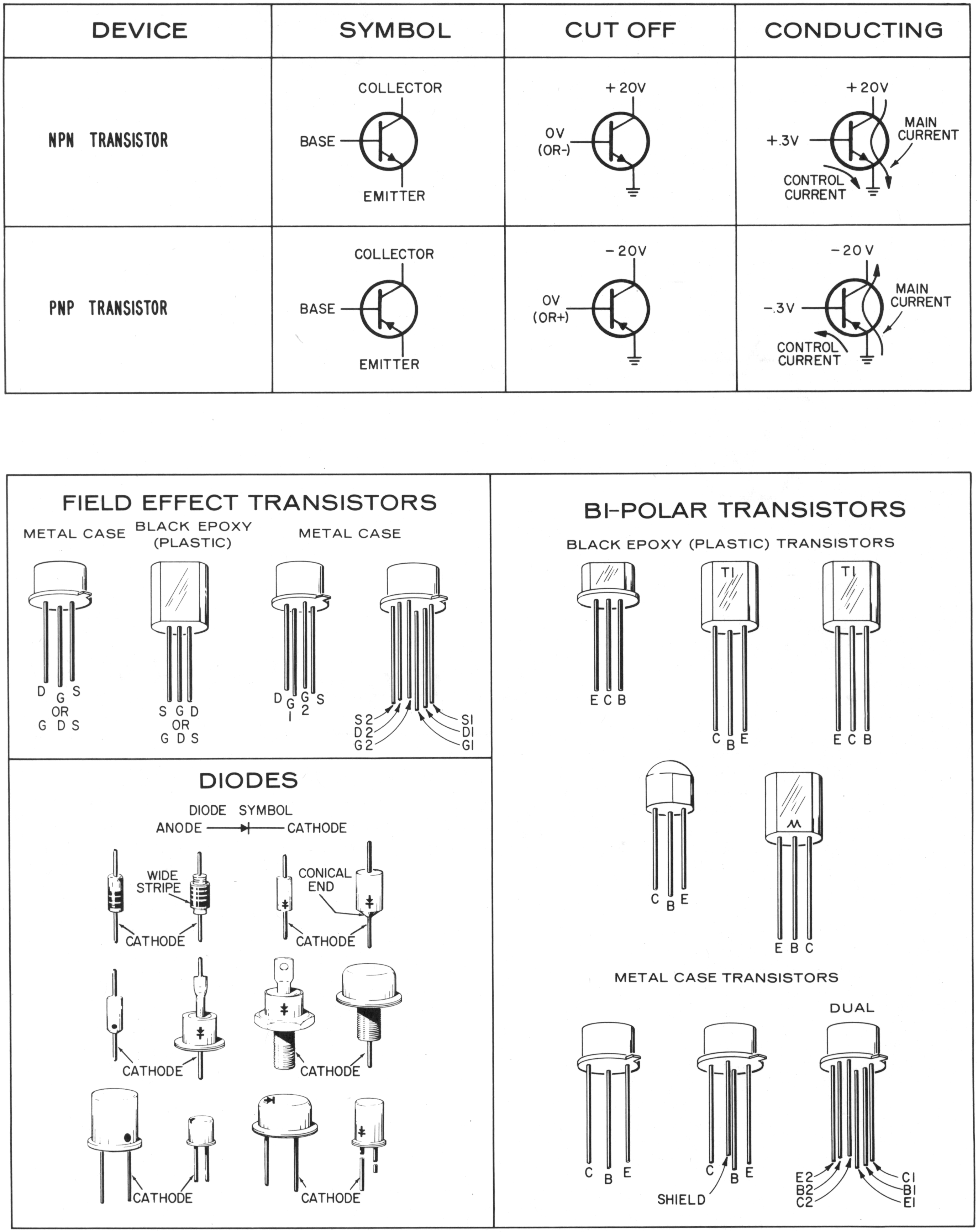

DEVICE
SYMBOL
CUT OFF
CONDUCTING
NPN TRANSISTOR
COLLECTOR
BASE
EMITTER
+20V
0V (OR-)
+20V
+.3V
MAIN CURRENT
CONTROL CURRENT
PNP TRANSISTOR
COLLECTOR
BASE
EMITTER
-20V
0V (OR+)
-20V
-.3V
MAIN CURRENT
CONTROL CURRENT
FIELD EFFECT TRANSISTORS
METAL CASE
BLACK EPOXY (PLASTIC)
METAL CASE
D G S
OR
G D S
S G D
OR
G D S
D G1 G2 S
S2
D2
G2
S1
D1
G1
DIODES
DIODE SYMBOL
ANODE
CATHODE
WIDE STRIPE
CATHODE
CONICAL END
CATHODE
CATHODE
CATHODE
CATHODE
CATHODE
BI-POLAR TRANSISTORS
BLACK EPOXY (PLASTIC) TRANSISTORS
E C B
TI
C B E
TI
E C B
C B E
E B C
METAL CASE TRANSISTORS
DUAL
C B E
C B E
SHIELD
E2
B2
C2
C1
B1
E1

Figure 5-4. Transistor Biasing and Operating Characteristics

Table 5-6. Etched Circuit Soldering Equipment

Item	Use	Specification	Item Recommended
Soldering Tool	Soldering, unsoldering	Wattage rating: 37.5 Tip Temp: 750-800°F Tip Size: 1/8" OD	Ungar #776 handle with Ungar #1237
Soldering Tip, General Purpose	Soldering, unsoldering	Shape: chisel Size: 1/8"	Ungar #PL113
De-soldering Aid	Unsoldering multiconnection components	Suction device to remove molten solder from connection	Soldapult by the Edsyn Company, Arleta, Calif.
Resin (flux) Solvent	Remove excess flux from soldered area before application of protection coating	Must not dissolve etched circuit base board material or conductor bonding agent	Freon, Acetone, Lacquer Thinner, Isopropyl Alcohol (100% dry)
Solder	Component replacement, circuit board repair or wiring	Resin (flux) core, high tin content (60/40 tin/lead), 18 gauge (SWG) preferred	
Protective Coating	Contamination, corrosion protection after soldering	Good electrical insulation, corrosion-preventive properties	Krylon #1320*, Humiseal Protective Coating, Type 1B12 by Columbia Technical Corp., Woodside 77, New York

*Krylon, Inc., Norristown, Pennsylvania

5-42. In-Circuit Testing. In transistor circuit testing the most important consideration is the transistor base-emitter junction. Like the control grid of a vacuum tube, this is the control point in the transistor.

5-43. To check a transistor, first see if the emitter-base diode is forward-biased by measuring the voltage difference between emitter and base. When using an electronic voltmeter, do not measure directly between emitter and base; there may be sufficient loop current between the voltmeter lead to damage the transistor. Instead, measure each voltage separately with respect to a voltage common point (e.g., chassis).

5-44. If the transistor base-emitter junction is forward-biased, the transistor conducts. If the diode is heavily forward-biased, the transistor saturates. However, if the base-emitter diode is reverse-biased, the transistor is cut off (open). The voltage drop across a forward-biased emitter-base junction varies with transistor collector current. A germanium transistor has a typical base-emitter voltage of 0.2-0.3-volt with 1-10 mA collector current and 0.4-0.5 volt with 10-100 mA collector current. In contrast, base-emitter voltage for silicon transistors is about twice that for germanium types; about 0.5-0.6 volt for low collector current, and about 0.8-0.9 for high collector current.

5-45. If the emitter base-junction is forward-biased, check for amplifier action by short-circuiting base to emitter while observing collector voltage. The transistor should stop conduction (cut off), which should shift the collector voltage close to the supply voltage. Any difference is due to current leakage through the transistor. In general, the smaller the current, the better the transistor. If collector voltage does not change, the transistor has either an emitter-collector short circuit or emitter-base open circuit.

5-46. OUT-OF-CIRCUIT TESTING.

5-47. The two common causes of transistor failure are internal short- and open-circuits. Remove the transistor from the circuit and use an ohmmeter to measure internal resistance. See Table 5-5 for measurement data.

5-48. COMPONENT REPLACEMENT IN ETCHED CIRCUITS.

5-49. General. Etched circuit boards are sensitive to heat and to scratches with sharp objects. This is because the conductors are plated onto the circuit boards and the plating extends through the component mounting holes. Whenever possible, avoid unnecessary component substitution; it can damage the circuit board and adjacent components. See Table 5-6 for recommended tools and materials.

5-50. AXIAL-LEAD COMPONENTS.

5-51. Resistors, tubular capacitors and other axial-lead components can be replaced without unsoldering. Cut the component leads near the body of the defec-

Table 5-7. Safe Ohmmeter Range for Transistor Resistance Measurements

	Safe Range(s)	Open Circuit Voltage	Short Circuit Current	Lead	
				Color	Polarity
HP 412 HP 427A	R x 1 k R x 10 K R x 100 k R x 1M R x 10M	1.0 V 1.0 V 1.0 V 1.0 V 1.0 V	1 mA 100 µA 10 µA 1 µA 0.1 µA	Red Black	+ -
HP 410C	R x 1 k R x 10 k R x 100 k R x 1M R x 10M	1.3 V 1.3 V 1.3 V 1.3 V 1.3 V	0.57 mA 57 µA 5.7 µA 0.5 µA 0.05 µA	Red Black	+ -
HP 410B	R x 100 R x 1 k R x 10 k R x 100 k R x 1M	1.1 V 1.1 V 1.1 V 1.1 V 1.1 V	1.1 mA 110 µA 11 µA 1.1 µA 0.11 µA	Black Red	+ -
Simpson 260	R x 100	1.5 V	1 mA	Red Black	+ -
Simpson 269	R x 1 k	1.5 V	0.82 mA	Black Red	+ -
Triplett 630	R x 100 R x 1 k	1.5 V 1.5 V	3.25 mA 325 µA	Varies with Serial Number	
Triplett 310	R x 10 R x 100	1.5 V 1.5 V	750 µA 75 µA		

tive component, remove the component and straighten the leads left in the board. Wrap leads of the replacement component one turn around the original leads, solder the connection, and clip off the excess lead.

5-52. OTHER COMPONENTS.

5-53. Replace other components as follows:

a. Remove defective component from circuit board. Use a low-power soldering iron because excessive heat may lift a conductor or damage the board.

b. Remove solder from mounting holes with a suction device or a wooden toothpick. DO NOT USE A SHARP METAL OBJECT SUCH AS AN AWL OR TWIST DRILL. SHARP OBJECTS MAY DAMAGE THE PLATED-THROUGH CONDUCTOR.

c. Shape the leads of the replacement component to match the mounting-hole spacing.

d. Insert the component leads in the mounting holes and position it as the original was. DO NOT FORCE LEADS OF REPLACEMENT COMPONENT INTO MOUNTING HOLES. A sharp edge on the lead may damage the plated-through conductor.

e. Solder the component in place and remove excess flux from the soldered areas. Apply a protective coating to prevent contamination and corrosion. See Table 5-6 for recommendations.

CAUTION

Most ohmmeters can supply enough current or voltage to damage a transistor. Before using an ohmmeter to measure transistor forward or reverse resistance, check its open-circuit voltage and short-circuit current output ON THE RANGE TO BE USED. Open-circuit voltage must not exceed 1.5 volts and short-circuit current must be less than 3 mA.

SECTION VI

REPLACEABLE PARTS

6-1. INTRODUCTION.

6-2. This section contains information for ordering replacement parts. Table 6-1 lists parts in alphanumerical order of their reference designators provides the following information on each part:

a. Description.

b. Manufacturer of the part in a five-digit code; see list of manufacturers in Table 6-2.

c. Manufacturer's part number.

d. Total quantity used (TQ column).

6-3. ORDERING INFORMATION.

6-4. To obtain replacement parts, address order or inquiry to your local Hewlett-Packard Field Office (see list at rear of this manual for addresses). Identify parts by their Hewlett-Packard stock numbers.

6-5. To obtain a part that is not listed, include:

a. Instrument model number.

b. Instrument serial number.

c. Description of the part.

d. Function and location of the part.

REFERENCE DESIGNATORS

A = assembly
B = motor
BT = battery
C = capacitor
CP = coupler
CR = diode
DL = delay line
DS = device signaling (lamp)
E = misc electronic part

F = fuse
FL = filter
IC = integrated circuit
J = jack
K = relay
L = inductor
LS = loud speaker
M = meter
MK = microphone

MP = mechanical part
P = plug
Q = transistor
R = resistor
RT = thermistor
S = switch
T = transformer
TB = terminal board
TP = test point

V = vacuum, tube, neon bulb, photocell, etc.
VR = voltage regulator
W = cable
X = socket
Y = crystal
Z = tuned cavity, network

ABBREVIATIONS

A = amperes
AFC = automatic frequency control
AMPL = amplifier

BFO = beat frequency oscillator
BE CU = beryllium copper
BH = binder head
BP = bandpass
BRS = brass
BWO = backward wave oscillator

CCW = counter-clockwise
CER = ceramic
CMO = cabinet mount only
COEF = coefficient
COM = common
COMP = composition
COMPL = complete
CONN = connector
CP = cadmium plate
CRT = cathode-ray tube
CW = clockwise

DEPC = deposited carbon
DR = drive

ELECT = electrolytic
ENCAP = encapsulated
EXT = external

F = farads
FH = flat head
FIL H = fillister head
FXD = fixed

G = giga (10^9)
GE = germanium
GL = glass
GRD = ground(ed)

H = henries
HDW = hardware
HEX = hexagonal
HG = mercury
HR = hour(s)
HZ = hertz

IF = intermediate freq
IMPG = impregnated
INCD = incandescent
INCL = include(s)
INS = insulation(ed)
INT = internal

K = kilo = 1000

LH = left hand
LIN = linear taper
LK WASH = lock washer
LOG = logarithmic taper
LPF = low pass filter

M = milli = 10^{-3}
MEG = meg = 10^6
MET FLM = metal film
MET OX = metallic oxide
MFR = manufacturer
MHZ = mega hertz
MINAT = miniature
MOM = momentary
MTG = mounting
MY = "mylar"

N = nano (10^{-9})
N/C = normally closed
NE = neon
NI PL = nickel plate

N/O = normally open
NPO = negative positive zero (zero temperature coefficient)

NPN = negative-positive-negative

NRFR = not recommended for field replacement

NSR = not separately replaceable

OBD = order by description
OH = oval head
OX = oxide

P = peak
PC = printed circuit
PF = picofarads = 10^{-12} farads

PH BRZ = phosphor bronze
PHL = Phillips
PIV = peak inverse voltage
PNP = positive-negative-positive

P/O = part of
POLY = polystyrene
PORC = porcelain
POS = position(s)
POT = potentiometer
PP = peak-to-peak
PT = point
PWV = peak working voltage

RECT = rectifier
RF = radio frequency
RH = round head or right hand

RMO = rack mount only
RMS = root-mean square
RWV = reverse working voltage

S-B = slow-blow
SCR = screw
SE = selenium
SECT = section(s)
SEMICON = semiconductor
SI = silicon
SIL = silver
SL = slide
SPG = spring
SPL = special
SST = stainless steel
SR = split ring
STL = steel

TA = tantalum
TD = time delay
TGL = toggle
THD = thread
TI = titanium
TOL = tolerance
TRIM = trimmer
TWT = traveling wave tube

U = micro = 10^{-6}

VAR = variable
VDCW = dc working volts

W/ = with
W = watts
WIV = working inverse voltage
WW = wirewound
W/O = without

Table 6-1. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A1	00432-60024	1	BOARD ASSY:BRIDGE	28480	00432-60024
A1A1	00432-6011	1	ASSY:AUTO ZERO	28480	00432-6011
A1C1	0180-0374	2	C:FXD TANT. 10 UF 10% 20VDCW	56289	150D106X9020B2-DYS
A1C2	0160-2055	8	C:FXD CER 0.01 UF +80-20% 100VDCW	56289	C023F101F103ZS22-CDH
A1C3	0160-2055		C:FXD CER 0.01 UF +80-20% 100VDCW	56289	C023F101F103ZS22-CDH
A1C4	0160-0380	2	C:FXD MY 0.22 UF 10% 200VDCW	28480	0160-0380
A1C5	0160-2055		C:FXD CER 0.01 UF +80-20% 100VDCW	56289	C023F101F103ZS22-CDH
A1C6	0160-2055		C:FXD CER 0.01 UF +80-20% 100VDCW	56289	C023F101F103ZS22-CDH
A1C7	0160-2055		C:FXD CER 0.01 UF +80-20% 100VDCW	56289	C023F101F103ZS22-CDH
A1C8	0160-0380		C:FXD MY 0.22 UF 10% 200VDCW	28480	0160-0380
A1C9	0160-2055		C:FXD CER 0.01 UF +80-20% 100VDCW	56289	C023F101F103ZS22-CDH
A1C10	0160-3459	2	C:FXD CER 0.02 UF 20% 100VDCW	56289	C023F101H203MS22CDH
A1C11	0160-3459		C:FXD CER 0.02 UF 20% 100VDCW	56289	C023F101H203MS22CDH
A1C12	0180-0374		C:FXD TANT. 10 UF 10% 20VDCW	56289	150D106X9020B2-DYS
A1C13	0160-2055		C:FXD CER 0.01 UF +80-20% 100VDCW	56289	C023F101F103ZS22-CDH
A1C14	0160-2055		C:FXD CER 0.01 UF +80-20% 100VDCW	56289	C023F101F103ZS22-CDH
A1CR1	1901-0040	2	DIODE:SILICON 30MA 30WV	07263	FDG1088
A1CR2			NOT ASSIGNED		
A1CR3	1901-0040		DIODE:SILICON 30MA 30WV	07263	FDG1088
A1Q1	1853-0020	13	TSTR:SI PNP(SELECTED FROM 2N3702)	28480	1853-0020
A1Q2	1853-0020		TSTR:SI PNP(SELECTED FROM 2N3702)	28480	1853-0020
A1Q3	1853-0020		TSTR:SI PNP(SELECTED FROM 2N3702)	28480	1853-0020
A1Q4	1854-0071	22	TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A1Q5	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A1Q6	1853-0001	3	TSTR:SI PNP(SELECTED FROM 2N1132)	28480	1853-0001
A1Q7	1854-0221	2	TSTR:SI NPN(REPL.BY 2N4044)	28480	1854-0221
A1Q8	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A1Q9	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A1Q10	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A1Q11	1853-0001		TSTR:SI PNP(SELECTED FROM 2N1132)	28480	1853-0001
A1Q12	1854-0221		TSTR:SI NPN(REPL.BY 2N4044)	28480	1854-0221
A1Q13	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A1Q14	1853-0020		TSTR:SI PNP(SELECTED FROM 2N3702)	28480	1853-0020
A1Q15	1853-0020		TSTR:SI PNP(SELECTED FROM 2N3702)	28480	1853-0020
A1R1	0698-3260	9	R:FXD MET FLM 464K OHM 1% 1/8W	28480	0698-3260
A1R2	0686-1055	1	R:FXD COMP 1 MEGOHM 5% 1/2W	01121	EB 1055
A1R3	0698-3160	13	R:FXD MET FLM 31.6K OHM 1% 1/8W	28480	0698-3160
A1R5	0698-3160		R:FXD MET FLM 31.6K OHM 1% 1/8W	28480	0698-3160
A1R6	0698-3160		R:FXD MET FLM 31.6K OHM 1% 1/8W	28480	0698-3160
A1R6			NOT ASSIGNED		
A1R7	0698-3156	7	R:FXD MET FLM 14.7K OHM 1% 1/8W	28480	0698-3156
A1R8	0757-0465	9	R:FXD MET FLM 100K OHM 1% 1/8W	28480	0757-0465
A1R9	0698-3136	1	R:FXD MET FLM 17.8K OHM 1% 1/8W	28480	0698-3136
A1R10	0698-3441	3	R:FXD MET FLM 215 OHM 1% 1/8W	28480	0698-3441
A1R11	0757-0401	4	R:FXD MET FLM 100 OHM 1% 1/8W	28480	0757-0401
A1R12	2100-1770	2	R:VAR WW 100 OHM 5% TYPE H 1W	28480	2100-1770
A1R12	0757-0439	4	R:FXD MET FLM 6.81K OHM 1% 1/8W	28480	0757-0439
A1R12			(FOR OPT 013)		
A1R12	0698-3449	2	R:FXD MET FLM 28.7K OHM 1% 1/8W	28480	0698-3449
A1R12			(OPT 011)		
A1R13	0757-0461	4	R:FXD MET FLM 68.1K OHM 1% 1/8W	28480	0757-0461
A1R13	0757-0443	2	R:FXD MET FLM 11.0K OHM 1% 1/8W	28480	0757-0443
A1R13			(FOR OPT 013)		
A1R13	0698-3162	2	R:FXD MET FLM 46.4K OHM 1% 1/8W	28480	0698-3162
A1R13			(OPT 011)		
A1R14	0811-2284	5	R:FXD WW 1K OHM 0.1% 1/40W	28480	0811-2284
A1R15	0757-0199	7	R:FXD MET FLM 21.5K OHM 1% 1/8W	28480	0757-0199
A1R16	0811-2284		R:FXD WW 1K OHM 0.1% 1/40W	28480	0811-2284
A1R17			NOT ASSIGNED		
A1R18			NOT ASSIGNED		
A1R19	0698-3441		R:FXD MET FLM 215 OHM 1% 1/8W	28480	0698-3441
A1R20	0698-3160		R:FXD MET FLM 31.6K OHM 1% 1/8W	28480	0698-3160
A1R21	0698-3160		R:FXD MET FLM 31.6K OHM 1% 1/8W	28480	0698-3160
A1R22	0698-3156		R:FXD MET FLM 14.7K OHM 1% 1/8W	28480	0698-3156
A1R23	0757-0465		R:FXD MET FLM 100K OHM 1% 1/8W	28480	0757-0465
A1R24	0757-0401		R:FXD MET FLM 100 OHM 1% 1/8W	28480	0757-0401
A1R25	2100-1770		R:VAR WW 100 OHM 5% TYPE H 1W	28480	2100-1770
A1R26	0757-0461		R:FXD MET FLM 68.1K OHM 1% 1/8W	28480	0757-0461
A1R27	0811-2284		R:FXD WW 1K OHM 0.1% 1/40W	28480	0811-2284
A1R28	0757-0199		R:FXD MET FLM 21.5K OHM 1% 1/8W	28480	0757-0199
A1R29	0811-2284		R:FXD WW 1K OHM 0.1% 1/40W	28480	0811-2284
A1R30	0757-0199		R:FXD MET FLM 21.5K OHM 1% 1/8W	28480	0757-0199
A1R31	0698-3260		R:FXD MET FLM 464K OHM 1% 1/8W	28480	0698-3260
A1R32	0757-0289	2	R:FXD MET FLM 13.3K OHM 1% 1/8W	28480	0757-0289
A1R32			(FOR OPT 012)		

Table 6-1. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A1R32	0757-0439		R:FXD MET FLM 6.81K OHM 1% 1/8W	28480	0757-0439
A1R32			(FOR OPT 013)		
A1R32	0698-3449		R:FXD MET FLM 28.7K OHM 1% 1/8W	28480	0698-3449
A1R32			(OPT 011)		
A1R33	0757-0465		R:FXD MET FLM 100K OHM 1% 1/8W	28480	0757-0465
A1R34	0757-0465		R:FXD MET FLM 100K OHM 1% 1/8W	28480	0757-0465
A1R35	0757-0442	11	R:FXD MET FLM 10.0K OHM 1% 1/8W	28480	0757-0442
A1R36	0757-0279	7	R:FXD MET FLM 3.16K OHM 1% 1/8W	28480	0757-0279
A1R37	0757-0279		R:FXD MET FLM 3.16K OHM 1% 1/8W	28480	0757-0279
A1R38	0757-0279		R:FXD MET FLM 3.16K OHM 1% 1/8W	28480	0757-0279
A1R39	0757-0279		R:FXD MET FLM 3.16K OHM 1% 1/8W	28480	0757-0279
A1R40	0698-3160		R:FXD MET FLM 31.6K OHM 1% 1/8W	28480	0698-3160
A1R41	0698-3160		R:FXD MET FLM 31.6K OHM 1% 1/8W	28480	0698-3160
A1R42	0757-0199		R:FXD MET FLM 21.5K OHM 1% 1/8W	28480	0757-0199
A1R42			(FOR OPT 012)		
A1R42	0757-0443		R:FXD MET FLM 11.0K OHM 1% 1/8W	28480	0757-0443
A1R42			(FOR OPT 013)		
A1R42	0698-3162		R:FXD MET FLM 46.4K OHM 1% 1/8W	28480	0698-3162
A1R42			(OPT 011)		
A1R42	0698-3455	1	R:FXD MET FLM 261K OHM 1% 1/8W	28480	0698-3455
A1R42			(OPT 010)		
A1R43	2100-1618	2	R:VAR FLM 1 MEGOHM 20% LIN 1/2W	28480	2100-1618
A1R44	0683-1855	1	R:FXD COMP 1.8 MEGOHM 5% 1/4W	01121	CB 1855
A1TP1	0360-0124	17	TERMINAL:SOLDER LUG	28480	0360-0124
A1TP2	0360-0124		TERMINAL:SOLDER LUG	28480	0360-0124
A1TP3			PART OF PC BOARD		
A1TP4	0360-0124		TERMINAL:SOLDER LUG	28480	0360-0124
A1TP5			PART OF PC BOARD		
A1TP6	0360-0124		TERMINAL:SOLDER LUG	28480	0360-0124
A1TP7	0360-0124		TERMINAL:SOLDER LUG	28480	0360-0124
A1TP8	0360-0124		TERMINAL:SOLDER LUG	28480	0360-0124
A1TP9	0360-0124		TERMINAL:SOLDER LUG	28480	0360-0124
A2	00432-6015	1	BOARD ASSY:LOGIC	28480	00432-6015
A2C1	0180-1819	1	C:FXD ELECT 100 UF +75-10% 50VDCW	28480	0180-1819
A2C2	0180-0229	3	C:FXD ELECT 33 UF 10% 10VDCW	28480	0180-0229
A2C3	0160-2917	6	C:FXD CER 0.05 UF +80-20% 100VDCW	84411	TYPE TA
A2C4			NOT ASSIGNED		
A2C5	0160-2917		C:FXD CER 0.05 UF +80-20% 100VDCW	84411	TYPE TA
A2C6					
THRU					
A2C20			NOT ASSIGNED		
A2C21	0140-0234	2	C:FXD MICA 500 PF 1%	28480	0140-0234
A2C22	0140-0234		C:FXD MICA 500 PF 1%	28480	0140-0234
A2C23	0180-1746	1	C:FXD ELECT 15 UF 10% 20VDCW	28480	0180-1746
A2C24	0140-0210	1	C:FXD MICA 270 PF 5%	28480	0140-0210
A2C25	0160-0978	1	C:FXD MICA 1500 PF 1% 500VDCW	28480	0160-0978
A2C26	0160-2930	4	C:FXD CER 0.01 UF +80-20% 100VDCW	91418	TA
A2C27			NOT ASSIGNED		
A2C28			NOT ASSIGNED		
A2C29	0180-2178	1	C:FXD ELECT 220 UF 20% 8VDCW	56289	109D227X0008F2-DYP
A2C30	0160-2930		C:FXD CER 0.01 UF +80-20% 100VDCW	91418	TA
A2C31	0180-1940	1	C:FXD ELECT 33 UF 10% 15VDCW	56289	109D336X9015C2-DYP
A2C33	0180-0197	5	C:FXD ELECT 2.2 UF 10% 20VDCW	56289	150D225X9020A2-DYS
A2C34	0160-2672	1	C:FXD MY 0.047 UF 5% 80VDCW	28480	0160-2672
A2C35	0180-0197		C:FXD ELECT 2.2 UF 10% 20VDCW	56289	150D225X9020A2-DYS
A2C36	0160-2917		C:FXD CER 0.05 UF +80-20% 100VDCW	84411	TYPE TA
A2C37			NOT ASSIGNED		
A2C38	0160-2917		C:FXD CER 0.05 UF +80-20% 100VDCW	84411	TYPE TA
A2C39	0160-2150	1	C:FXD MICA 33 PF 5%	28480	0160-2150
A2C40	0180-0229		C:FXD ELECT 33 UF 10% 10VDCW	28480	0180-0229
A2C41	0160-2917		C:FXD CER 0.05 UF +80-20% 100VDCW	84411	TYPE TA
A2C42	0180-0106	2	C:FXD ELECT 60 UF 20% 6VDCW	28480	0180-0106
A2C43	0180-0197		C:FXD ELECT 2.2 UF 10% 20VDCW	56289	150D225X9020A2-DYS
A2C44	0180-0197		C:FXD ELECT 2.2 UF 10% 20VDCW	56289	150D225X9020A2-DYS
A2C45	0180-0106		C:FXD ELECT 60 UF 20% 6VDCW	28480	0180-0106
A2C45	0180-1714	1	C:FXD ELECT 330 UF 10% 6VDCW	28480	0180-1714
A2C45			(OPT 011,012,013)		
A2C46	0160-2253	1	C:FXD CER 6.8 PF 500VDCW	72982	301-NPO-6.8 PF
A2C47	0160-2930		C:FXD CER 0.01 UF +80-20% 100VDCW	91418	TA
A2C48			NOT ASSIGNED		
A2C49	0180-0229		C:FXD ELECT 33 UF 10% 10VDCW	28480	0180-0229
A2C50	0160-2917		C:FXD CER 0.05 UF +80-20% 100VDCW	84411	TYPE TA
A2CR1	1901-0026	20	DIODE:SILICON 0.75A 200PIV	04713	SR1358-8
A2CR2	1901-0026		DIODE:SILICON 0.75A 200PIV	04713	SR1358-8
A2CR3	1901-0026		DIODE:SILICON 0.75A 200PIV	04713	SR1358-8

Table 6-1. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A2CR4	1901-0026		DIODE:SILICON 0.75A 200PIV	04713	SR1358-8
A2CR5	1901-0026		DIODE:SILICON 0.75A 200PIV	04713	SR1358-8
A2CR6	1902-0509	1	DIODE BREAKDOWN:6.20V 2%	04713	SZ50984
A2CR7	1901-0026		DIODE:SILICON 0.75A 200PIV	04713	SR1358-8
A2CR8	1901-0026		DIODE:SILICON 0.75A 200PIV	04713	SR1358-8
A2CR9			NOT ASSIGNED		
A2CR10			NOT ASSIGNED		
A2CR11	1901-0026		DIODE:SILICON 0.75A 200PIV	04713	SR1358-8
A2CR12	1901-0026		DIODE:SILICON 0.75A 200PIV	04713	SR1358-8
A2CR13			NOT ASSIGNED		
A2CR14	1901-0026		DIODE:SILICON 0.75A 200PIV	04713	SR1358-8
A2CR15	1901-0026		DIODE:SILICON 0.75A 200PIV	04713	SR1358-8
A2CR16	1901-0026		DIODE:SILICON 0.75A 200PIV	04713	SR1358-8
A2CR17	1901-0026		DIODE:SILICON 0.75A 200PIV	04713	SR1358-8
A2CR18	1901-0026		DIODE:SILICON 0.75A 200PIV	04713	SR1358-8
A2CR19	1901-0026		DIODE:SILICON 0.75A 200PIV	04713	SR1358-8
A2CR20	1901-0026		DIODE:SILICON 0.75A 200PIV	04713	SR1358-8
A2CR21	1901-0026		DIODE:SILICON 0.75A 200PIV	04713	SR1358-8
A2CR22	1901-0026		DIODE:SILICON 0.75A 200PIV	04713	SR1358-8
A2CR23	1901-0026		DIODE:SILICON 0.75A 200PIV	04713	SR1358-8
A2Q1	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A2Q2	1854-0062	1	TSTR:SI NPN	80131	2N1701
A2Q3	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A2Q4	1853-0012	1	TSTR:SI PNP	80131	2N2904A
A2Q5	1853-0020		TSTR:SI PNP(SELECTED FROM 2N3702)	28480	1853-0020
A2Q6	1853-0020		TSTR:SI PNP(SELECTED FROM 2N3702)	28480	1853-0020
A2Q7	1853-0020		TSTR:SI PNP(SELECTED FROM 2N3702)	28480	1853-0020
A2Q8	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A2Q9	1854-0003	1	TSTR:SI NPN(SELECTED FROM 2N1711)	28480	1854-0003
A2Q10	1853-0001		TSTR:SI PNP(SELECTED FROM 2N1132)	28480	1853-0001
A2Q11	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A2Q12			NOT ASSIGNED		
A2Q19			NOT ASSIGNED		
A2Q20	1853-0020		TSTR:SI PNP(SELECTED FROM 2N3702)	28480	1853-0020
A2Q21	1854-0005	2	TSTR:SI NPN	80131	2N708
A2Q22	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A2Q23	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A2Q24	1854-0005		TSTR:SI NPN	80131	2N708
A2Q25			NOT ASSIGNED		
A2Q26	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A2Q27	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A2Q28	1854-0009	2	TSTR:SI NPN	80131	2N709
A2Q29	1854-0009		TSTR:SI NPN	80131	2N709
A2Q30	1855-0062	3	TSTR:SI FET 30V	01295	2N1595
A2Q31			NOT ASSIGNED		
A2Q32	1855-0062		TSTR:SI FET 30V	01295	2N1595
A2Q33			NOT ASSIGNED		
A2Q34	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A2Q35	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A2Q36	1853-0015	1	TSTR:SI PNP	80131	2N3640
A2Q37	1853-0020		TSTR:SI PNP(SELECTED FROM 2N3702)	28480	1853-0020
A2Q38	1855-0062		TSTR:SI FET 30V	01295	2N1595
A2Q39	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A2Q40	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A2Q41	1853-0020		TSTR:SI PNP(SELECTED FROM 2N3702)	28480	1853-0020
A2Q42	1853-0020		TSTR:SI PNP(SELECTED FROM 2N3702)	28480	1853-0020
A2Q43	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A2Q44	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A2R1	0757-0279		R:FXD MET FLM 3.16K OHM 1% 1/8W	28480	0757-0279
A2R2	0683-0685	1	R:FXD COMP 6.8 OHM 5% 1/4W	01121	CB68G5
A2R3	0757-0835	1	R:FXD MET FLM 6.81K OHM 1% 1/2W	28480	0757-0835
A2R4			NOT ASSIGNED		
A2R5	0757-0447	2	R:FXD MET FLM 16.2K OHM 1% 1/8W	28480	0757-0447
A2R6	2100-1773	1	R:VAR WW 1K OHM 5% TYPE H 1W	28480	2100-1773
A2R7	0757-0289		R:FXD MET FLM 13.3K OHM 1% 1/8W	28480	0757-0289
A2R8	0757-0280	4	R:FXD MET FLM 1K OHM 1% 1/8W	28480	0757-0280
A2R9	0757-0458	2	R:FXD MET FLM 51.1K OHM 1% 1/8W	28480	0757-0458
A2R10	0757-0401		R:FXD MET FLM 100 OHM 1% 1/8W	28480	0757-0401
A2R11	0757-0465		R:FXD MET FLM 100K OHM 1% 1/8W	28480	0757-0465
A2R12	0757-0442		R:FXD MET FLM 10.0K OHM 1% 1/8W	28480	0757-0442
A2R13	0757-0447		R:FXD MET FLM 16.2K OHM 1% 1/8W	28480	0757-0447
A2R14			NOT ASSIGNED		
A2R15	0757-0442		R:FXD MET FLM 10.0K OHM 1% 1/8W	28480	0757-0442
A2R16	0757-0279		R:FXD MET FLM 3.16K OHM 1% 1/8W	28480	0757-0279
A2R17	0757-0198	2	R:FXD MET FLM 100 OHM 1% 1/2W	28480	0757-0198

See introduction to this section for ordering information

Table 6-1. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A2R18	0698-3401	1	R:FXD MET FLM 215 OHM 1% 1/2W	28480	0698-3401
A2R19			NOT ASSIGNED		
A2R20			NOT ASSIGNED		
A2R21	0698-3156		R:FXD MET FLM 14.7K OHM 1% 1/8W	28480	0698-3156
A2R22	0757-0442		R:FXD MET FLM 10.0K OHM 1% 1/8W	28480	0757-0442
A2R23	0757-0442		R:FXD MET FLM 10.0K OHM 1% 1/8W	28480	0757-0442
A2R24	0698-3260		R:FXD MET FLM 464K OHM 1% 1/8W	28480	0698-3260
A2R25	0698-3260		R:FXD MET FLM 464K OHM 1% 1/8W	28480	0698-3260
A2R26	0757-0442		R:FXD MET FLM 10.0K OHM 1% 1/8W	28480	0757-0442
A2R27	0757-0442		R:FXD MET FLM 10.0K OHM 1% 1/8W	28480	0757-0442
A2R28	0698-3156		R:FXD MET FLM 14.7K OHM 1% 1/8W	28480	0698-3156
A2R29	0757-0397	1	R:FXD MET FLM 68.1 OHM 1% 1/8W	28480	0757-0397
A2R30			NOT ASSIGNED		
A2R31			NOT ASSIGNED		
A2R32	0757-0199		R:FXD MET FLM 21.5K OHM 1% 1/8W	28480	0757-0199
A2R33	0757-0442		R:FXD MET FLM 10.0K OHM 1% 1/8W	28480	0757-0442
A2R34	0757-0465		R:FXD MET FLM 100K OHM 1% 1/8W	28480	0757-0465
A2R35	0698-3266	1	R:FXD MET FLM 237K OHM 1% 1/8W	28480	0698-3266
A2R36	0757-0461		R:FXD MET FLM 68.1K OHM 1% 1/8W	28480	0757-0461
A2R37	0698-3160		R:FXD MET FLM 31.6K OHM 1% 1/8W	28480	0698-3160
A2R38	0757-0465		R:FXD MET FLM 100K OHM 1% 1/8W	28480	0757-0465
A2R39	0698-3155	4	R:FXD MET FLM 4.64K OHM 1% 1/8W	28480	0698-3155
A2R40	0698-3155		R:FXD MET FLM 4.64K OHM 1% 1/8W	28480	0698-3155
A2R41	0757-0465		R:FXD MET FLM 100K OHM 1% 1/8W	28480	0757-0465
A2R42	0683-1065	3	R:FXD COMP 10M OHM 5% 1/4W	01121	CB 1065
A2R43	0757-1094	1	R:FXD MET FLM 1.47K OHM 1% 1/8W	28480	0757-1094
A2R44			NOT ASSIGNED		
A2R45			NOT ASSIGNED		
A2R46	0757-0465		R:FXD MET FLM 100K OHM 1% 1/8W	28480	0757-0465
A2R47	0683-1065		R:FXD COMP 10M OHM 5% 1/4W	01121	CB 1065
A2R48			NOT ASSIGNED		
A2R49			NOT ASSIGNED		
A2R50	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	28480	0757-0280
A2R51	0698-3260		R:FXD MET FLM 464K OHM 1% 1/8W	28480	0698-3260
A2R52	0757-0279		R:FXD MET FLM 3.16K OHM 1% 1/8W	28480	0757-0279
A2R53	0698-3160		R:FXD MET FLM 31.6K OHM 1% 1/8W	28480	0698-3160
A2R54	0698-3428	1	R:FXD MET FLM 14.7 OHM 1% 1/8W	28480	0698-3428
A2R55	0698-3160		R:FXD MET FLM 31.6K OHM 1% 1/8W	28480	0698-3160
A2R56	0698-3260		R:FXD MET FLM 464K OHM 1% 1/8W	28480	0698-3260
A2R56			FACTORY SELECTED PART		
A2R57	0757-0442		R:FXD MET FLM 10.0K OHM 1% 1/8W	28480	0757-0442
A2R58	0698-3260		R:FXD MET FLM 464K OHM 1% 1/8W	28480	0698-3260
A2R59	0698-3260		R:FXD MET FLM 464K OHM 1% 1/8W	28480	0698-3260
A2R60	0698-0084	2	R:FXD MET FLM 2.15K OHM 1% 1/8W	28480	0698-0084
A2R61	0683-1055	1	R:FXD COMP 1 MEGOHM 5% 1/4W	01121	CB 1055
A2R61			NOT ASSIGNED		
A2R62			NOT ASSIGNED		
A2R63	0698-3260		R:FXD MET FLM 464K OHM 1% 1/8W	28480	0698-3260
A2R64	0757-0439		R:FXD MET FLM 6.81K OHM 1% 1/8W	28480	0757-0439
A2R65	0757-0442		R:FXD MET FLM 10.0K OHM 1% 1/8W	28480	0757-0442
A2R66	0757-0461		R:FXD MET FLM 68.1K OHM 1% 1/8W	28480	0757-0461
A2R67	0698-3160		R:FXD MET FLM 31.6K OHM 1% 1/8W	28480	0698-3160
A2R68	0757-0442		R:FXD MET FLM 10.0K OHM 1% 1/8W	28480	0757-0442
A2R69	0698-3438	1	R:FXD MET FLM 147 OHM 1% 1/8W	28480	0698-3438
A2R70	0698-3156		R:FXD MET FLM 14.7K OHM 1% 1/8W	28480	0698-3156
A2R71	0698-3160		R:FXD MET FLM 31.6K OHM 1% 1/8W	28480	0698-3160
A2R72	0757-0401		R:FXD MET FLM 100 OHM 1% 1/8W	28480	0757-0401
A2R73	0757-0199		R:FXD MET FLM 21.5K OHM 1% 1/8W	28480	0757-0199
A2R74	2100-1769	1	R:VAR WW 50 OHM 5% TYPE H 1W	28480	2100-1769
A2R75	0698-4466	1	R:FXD MET FLM 976 OHM 1% 1/8W	28480	0698-4466
A2R76	0757-0346	14	R:FXD MET FLM 10 OHM 1% 1/8W	28480	0757-0346
A2R77	0698-3160		R:FXD MET FLM 31.6K OHM 1% 1/8W	28480	0698-3160
A2R78	0811-2277	3	R:FXD WW 10K OHM 0.1% 1/40W	28480	0811-2277
A2R79	0811-2277		R:FXD WW 10K OHM 0.1% 1/40W	28480	0811-2277
A2R80	0811-2537	1	R:FXD WW 5K OHM 0.1% 1/40W	28480	0811-2537
A2R81			NOT ASSIGNED		
A2R82			NOT ASSIGNED		
A2R83	0698-3441		R:FXD MET FLM 215 OHM 1% 1/8W	28480	0698-3441
A2R84			NOT ASSIGNED		
A2R85			NOT ASSIGNED		
A2R86	2100-1618		R:VAR FLM 1 MEGOHM 20% LIN 1/2W	28480	2100-1618
A2R87	0683-1065		R:FXD COMP 10M OHM 5% 1/4W	01121	CB 1065
A2R88	0757-0405	1	R:FXD MET FLM 162 OHM 1% 1/8W	28480	0757-0405
A2S1	3101-0973	1	SWITCH:SLIDE DPDT 0.5A 125V AC/DC	79727	G126-0018
A2TP1	0360-0124		TERMINAL:SOLDER LUG	28480	0360-0124

See introduction to this section for ordering information

Table 6-1. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A2TP2	0360-0124		TERMINAL:SOLDER LUG	28480	0360-0124
A2TP3	0360-0124		TERMINAL:SOLDER LUG	28480	0360-0124
A2TP4	0360-0124		TERMINAL:SOLDER LUG	28480	0360-0124
A2TP5	0360-0124		TERMINAL:SOLDER LUG	28480	0360-0124
A2TP6	0360-0124		TERMINAL:SOLDER LUG	28480	0360-0124
A2TP7	0360-0124		TERMINAL:SOLDER LUG	28480	0360-0124
A2TP8	0360-0124		TERMINAL:SOLDER LUG	28480	0360-0124
A2TP9	0360-0124		TERMINAL:SOLDER LUG	28480	0360-0124
A2TP10	0360-0124		TERMINAL:SOLDER LUG	28480	0360-0124
A3	00432-6003	1	SWITCH ASSY:RANGE 110^{00} EA N STOCK	28480	00432-6003
A3R1	0811-2536	1	R:FXD WW 3167 OHM 0.1% 1/40W	28480	0811-2536
A3R2	0811-2284		R:FXD WW 1K OHM 0.1% 1/40W	28480	0811-2284
A3R3	0811-2534	1	R:FXD WW 314.3 OHM 0.1% 1/40W	28480	0811-2534
A3R4	0811-2535	1	R:FXD WW 145.0 OHM 0.1% 1/40W	28480	0811-2535
A3S1	3100-2470	1	SWITCH:ROTARY	28480	3100-2470
A4	00432-6004	1	SWITCH ASSY:CALIBRATION FACTOR	28480	00432-6004
A4R1	0757-0346		R:FXD MET FLM 10 OHM 1% 1/8W	28480	0757-0346
A4R2	0757-0346		R:FXD MET FLM 10 OHM 1% 1/8W	28480	0757-0346
A4R3	0757-0346		R:FXD MET FLM 10 OHM 1% 1/8W	28480	0757-0346
A4R4	0757-0346		R:FXD MET FLM 10 OHM 1% 1/8W	28480	0757-0346
A4R5	0757-0346		R:FXD MET FLM 10 OHM 1% 1/8W	28480	0757-0346
A4R6	0757-0346		R:FXD MET FLM 10 OHM 1% 1/8W	28480	0757-0346
A4R7	0757-0346		R:FXD MET FLM 10 OHM 1% 1/8W	28480	0757-0346
A4R8	0757-0346		R:FXD MET FLM 10 OHM 1% 1/8W	28480	0757-0346
A4R9	0757-0346		R:FXD MET FLM 10 OHM 1% 1/8W	28480	0757-0346
A4R10	0757-0346		R:FXD MET FLM 10 OHM 1% 1/8W	28480	0757-0346
A4R11	0757-0346		R:FXD MET FLM 10 OHM 1% 1/8W	28480	0757-0346
A4R12	0757-0346		R:FXD MET FLM 10 OHM 1% 1/8W	28480	0757-0346
A4R13	0698-6635	1	R:FXD MET FLM 880 OHM 1% 1/8W	28480	0698-6635
A4S1	3100-2469	1	SWITCH:ROTARY	28480	3100-2469
A5			NOT ASSIGNED		
A6			NOT ASSIGNED		
A7	00432-6007	1	BOARD ASSY:BATTERY CHARGER	28480	00432-6007
A7			(FOR OPTION 001)		
A7C1	0160-2930		C:FXD CER 0.01 UF +80-20% 100VDCW	91418	TA
A7CR1	1901-0026		DIODE:SILICON 0.75A 200PIV	04713	SR1358-8
A7CR2	1902-0048	1	DIODE:BREAKDOWN 6.81V 5%	04713	SZ10939-134
A7Q1	1854-0039	1	TSTR:SI NPN	80131	2N3053
A7Q2	1853-0020		TSTR:SI PNP(SELECTED FROM 2N3702)	28480	1853-0020
A7Q3	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A7Q4	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A7R1	0698-3635	1	R:FXD MET OX 680 OHM 5% 2W	28480	0698-3635
A7R2	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	28480	0757-0280
A7R3	0757-0346		R:FXD MET FLM 10 OHM 1% 1/8W	28480	0757-0346
A7R4	0757-0439		R:FXD MET FLM 6.81K OHM 1% 1/8W	28480	0757-0439
A7R5	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	28480	0757-0280
A7R6	0757-0199		R:FXD MET FLM 21.5K OHM 1% 1/8W	28480	0757-0199
A7R7	0698-3156		R:FXD MET FLM 14.7K OHM 1% 1/8W	28480	0698-3156
A7R7			FACTORY SELECTED PART		
A7R8	2100-1776	1	R:VAR WW 10K OHM 5% TYPE H 1W	28480	2100-1776

See introduction to this section for ordering information

Table 6-1. Replaceable Parts

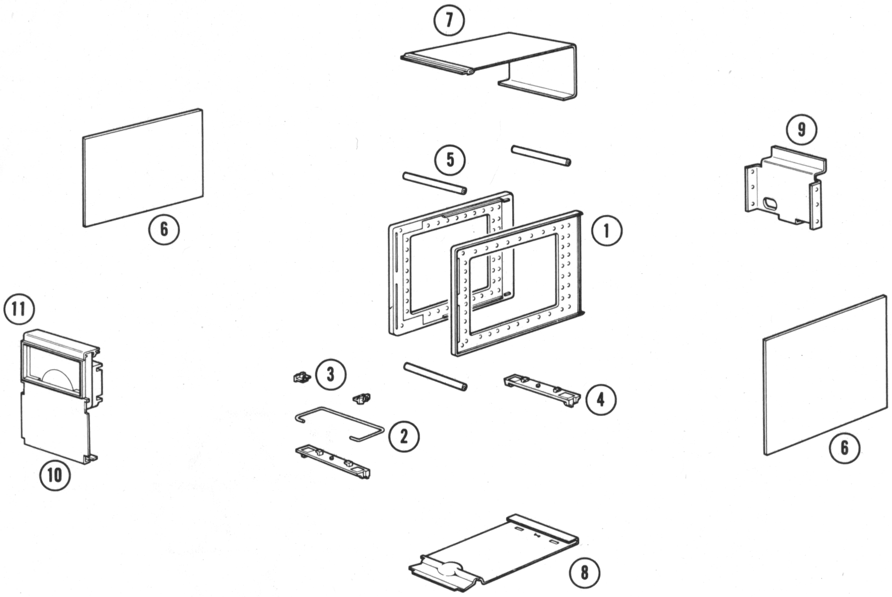
Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
			CHASSIS & MISCELLANEOUS PARTS		
B1	1420-0062	1	BATTERY:RECHARGEABLE 24V	28480	1420-0062
B1			(OPT 001)		
C1	0160-3043	1	C:FXD CER 2 X 0.005 UF 20% 250VAC	56289	29C147A-CDH
C2	0180-0197		C:FXD ELECT 2.2 UF 10% 20VDCW	56289	150D225X9020A2-DYS
C2			(OPT 011, 012, 013)		
DS1	2140-0244	1	LAMP:GLOW MINIATURE 95V	87034	A1H
F1	2110-0234	1	FUSE:0.1 AMP 250V SLOW-BLOW	75915	313.100/S
J1	1251-1280	1	CONNECTOR:AUDIO 6 FEMALE CONTACTS	28480	1251-1280
J1	00432-2005	1	NUT:CONNECTOR	28480	00432-2005
J2	1250-0118	3	CONNECTOR:BNC	24931	28JR 128-1
J3	1250-0118		CONNECTOR:BNC	24931	28JR 128-1
J4	1250-0118		CONNECTOR:BNC	24931	28JR 128-1
J5	1251-2357	1	SOCKET:3-PIN MALE POWER RECEPTACLE	82389	EAC-301
J5			(PART OF REAR PANEL)		
M1	1120-1497	1	METER	28480	1120-1497
MP1	0370-0077	1	KNOB:SKIRTED BAR FOR 0.250" DIA SHAFT	28480	0370-0077
MP1			(RANGE)		
MP2	0370-0193	1	KNOB:ROTARY POINTER BLACK	28480	0370-0193
MP2			(CAL FACTOR)		
MP3	0370-0432	1	KNOB:BLACK LEVER	28480	0370-0432
MP3			(MT. RES.)		
MP4	5040-0345	6	INSULATOR:CONNECTOR(LIGHT GRAY)	28480	5040-0345
MP4	5040-0702	6	INSULATOR:CONNECTOR(BLACK)	28480	5040-0702
MP5	0403-0131	2	GUIDE:P.C. BOARD, GREY	28480	0403-0131
MP6	0403-0026	1	GLIDE:NYLON	28480	0403-0026
MP6			(OPT 001)		
MP6	00432-0005	1	BRACKET:TRANSFORMER	28480	00432-0005
MP7	00432-0006	1	DECK:LOWER	28480	00432-0006
MP8	00432-0007	1	DECK:UPPER	28480	00432-0007
MP9	00432-0011	1	BRACKET:FRAME	28480	00432-0011
R1	2100-2849	1	R:VAR WW 50K OHM 3% LIN 2W	28480	2100-2849
R1	2950-0034	1	NUT:HEX BRASS 3/8-32 X 1/2"	28480	2950-0034
R1	00432-2004	1	BUSHING:PANEL	28480	00432-2004
R2	0811-2538	4	R:FXD WW 100 OHM 0.1% 1/10W	28480	0811-2538
R3	0811-2538		R:FXD WW 100 OHM 0.1% 1/10W	28480	0811-2538
R4	0811-2538		R:FXD WW 100 OHM 0.1% 1/10W	28480	0811-2538
R5	0811-2538		R:FXD WW 100 OHM 0.1% 1/10W	28480	0811-2538
R6	0757-0984	2	R:FXD MET FLM 10.0 OHM 1% 1/2W	28480	0757-0984
R7	0757-0984		R:FXD MET FLM 10.0 OHM 1% 1/2W	28480	0757-0984
R8	0757-0198		R:FXD MET FLM 100 OHM 1% 1/2W	28480	0757-0198
R9	0757-0458		R:FXD MET FLM 51.1K OHM 1% 1/8W	28480	0757-0458
R10	0757-0200	1	R:FXD MET FLM 5.62K OHM 1% 1/8W	28480	0757-0200
R10			(FOR OPT 011)		
R10	0698-3151	1	R:FXD MET FLM 2.87K OHM 1% 1/8W	28480	0698-3151
R10			(OPT 012)		
R10	0757-0317	1	R:FXD MET FLM 1.33K OHM 1% 1/8W	28480	0757-0317
R10			(FOR OPT 011)		
R11	0757-0288	1	R:FXD MET FLM 9.09K OHM 1% 1/8W	28480	0757-0288
R11			(FOR OPT 011)		
R11	0698-3155		R:FXD MET FLM 4.64K OHM 1% 1/8W	28480	0698-3155
R11			(OPT 012)		
R11	0698-0084		R:FXD MET FLM 2.15K OHM 1% 1/8W	28480	0698-0084
R11			(OPT 013)		
R12	0698-3156		R:FXD MET FLM 14.7K OHM 1% 1/8W	28480	0698-3156
R12			(OPT 012)		
R13	0698-3158	1	R:FXD MET FLM 23.7K OHM 1% 1/8W	28480	0698-3158
R13			(OPT 012)		
R14	0811-2277		R:FXD WW 10K OHM 0.1% 1/40W	28480	0811-2277
S1	3101-1395	1	SWITCH:PUSHBUTTON DPDT-DB	76854	53-67280-121/A1H
S1			(POWER)		
S2	3101-1234	1	SWITCH:SLIDE DPDT	82389	11A-1242
S2			(PART OF REAR PANEL)		
S3	3100-2485	1	SWITCH:LEVER SINGLE SECTION	76854	TYPE 184
S3			(MT. RES.)		
S3	00432-00031	1	SWITCH PLATE	28480	00432-00031
S4	3101-1357	1	SWITCH:TOGGLE SPDT	09353	7109
S4			(FINE ZERO)		
S4	00432-2003	1	NUT:DRESS	28480	00432-2003
W1	8120-1082	1	CABLE ASSY:5 FT	28480	8120-1082
W1	8120-1083	1	CABLE ASSY:SPECIAL PURPOSE(10 FT)	28480	8120-1083
W1			(OPT 009)		
W1	8120-1084	1	CABLE ASSY:SPECIAL PURPOSE(20 FT)	28480	8120-1084
W1			(OPT 010)		

Table 6-1. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
W1	8120-1359	1	THERMO CABLE:SPECIAL PURPOSE(50 FT)	28480	8120-1359
W1			(OPT 011)		
W1	8120-1360	1	THERMO CABLE:SPECIAL PURPOSE(100 FT)	28480	8120-1360
W1			(OPT 012)		
W1	8120-1361	1	THERMO CABLE:SPECIAL PURPOSE(200 FT)	28480	8120-1361
W1			(OPT 013)		
W2	8120-1348	1	CABLE ASSY:POWER, DETACHABLE	70903	KHS-7041
W3	00432-6010	1	CABLE ASSY:POWER SWITCH	28480	00432-6010
XA1	1251-0172	2	CONNECTOR:PC EDGE 1 ROW 22 CONTACT	71785	250-22-30-210
XA1			(PART OF LOWER DECK)		
XA2	1251-0172		CONNECTOR:PC EDGE 1 ROW 22 CONTACT	71785	250-22-30-210
XA2			(PART OF LOWER DECK)		
XB1	00432-0008	1	BRACKET:BATTERY UPPER	28480	00432-0008
XB1			(OPT 001)		
XB1	00432-0009	1	BRACKET:BATTERY LOWER	28480	00432-0009
			(OPT 001)		
XF1	1400-0084	1	FUSEHOLDER:EXTRACTOR POST TYPE	75915	342014

See introduction to this section for ordering information

Table 6-1. Replaceable Parts



Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
			CABINET PARTS		
1	5060-0703		FRAME ASSY:6 X 11 SM	28480	5060-0703
2	1490-0031		STAND:TILT	28480	1490-0031
3	5040-0700		HINGE	28480	5040-0700
4	5060-0727		FOOT ASSY	28480	5060-0727
5	5020-0700		SPACER:CABINET	28480	5020-0700
6	5000-0703		SIDE COVER-BLUE GRAY	28480	5000-0703
6	5000-8565		SIDE COVER-OLIVE GRAY	28480	5000-8565
7	5060-0706		TOP COVER-BLUE GRAY	28480	5060-0706
7	5060-8549		TOP COVER-OLIVE GRAY	50436	5060-8549
8	5000-0711		BOTTOM COVER-BLUE GRAY	28480	5000-0711
8	5000-8571		BOTTOM COVER-OLIVE GRAY	28480	5000-8571
9	00432-00022		REAR PANEL	50436	00432-00022
10	00432-00021		FRONT PANEL-LIGHT GRAY	50436	00432-00021
10	00432-00033		FRONT PANEL - MINT GRAY	50436	00432-00033
11	5020-0704		METER TRIM: - LIGHT GRAY	28480	5020-0704
11	5020-7633		METER TRIM: - MINT GRAY	28480	5020-7633

Table 6-2. Code List of Manufacturers

432B MANUFACTURERS CODE LIST AS OF 06/03/72 PAGE 3

MFR NO.	MANUFACTURER NAME	ADDRESS	ZIP CODE
01121	ALLEN BRADLEY CO.	MILWAUKEE, WIS.	53204
01295	TEXAS INSTRUMENTS INC. SEMICONDUCTOR COMPONENTS DIV.	DALLAS, TEX.	75231
04713	MOTOROLA SEMICONDUCTOR PROD.INC.	PHOENIX, ARIZ.	85008
07263	FAIRCHILD CAMERA & INST. CORP. SEMICONDUCTOR DIV.	MOUNTAIN VIEW, CALIF.	94040
09353	C & K COMPONENTS INC.	NEWTON, MASS.	02158
24931	SPECIALTY CONNECTOR CO. INC.	INDIANAPOLIS, IND.	46227
28480	HEWLETT-PACKARD CO. CORPORATE HQ	PALO ALTO, CALIF.	94304
50436	HEWLETT-PACKARD CO. MICROWAVE DIV	PALO ALTO, CALIF	94304
56289	SPRAGUE ELECTRIC CO.	N. ADAMS, MASS.	01247
70903	BELDEN CORP.	CHICAGO, ILL.	60644
71785	CINCH MFG. CO. DIV TRW INC.	ELK GROVE VILLAGE, ILL.	
72982	ERIE TECHNOLOGICAL PROD. INC.	ERIE, PA.	16512
75915	LITTELFUSE INC.	DES PLAINES, ILL.	60016
76854	OAK MFG. CO. DIV. OAK ELECTRO/NETICS CORP.	CRYSTAL LAKE, ILL.	60014
79727	CONTINENTAL-WIRT ELECTRONICS CORP.	WARMINSTER, PA.	18974
80131	ELECTRONIC INDUSTRIES ASSOCIATION	WASHINGTON D.C.	20006
82389	SWITCHCRAFT INC.	CHICAGO, ILL.	60630
84411	TRW CAPACITOR DIV.	OGALLALA, NEBR.	69153
87034	MARCOAK INDUSTRIES	ANAHEIM, CALIF.	92803
91418	RADIO MATERIALS CO.	CHICAGO, ILL.	60646

See introduction to this section for ordering information

SECTION VII

TROUBLESHOOTING, SCHEMATICS, AND COMPONENT LOCATIONS

7-1. INTRODUCTION.

7-2. This section contains troubleshooting instructions, schematics, and component locations for the power meter. Also included is an overall block diagram that indicates the location of test points in the instrument.

7-3. Reference designations shown within circuit card outlines are abbreviated. To find the part in the Parts List, use the full reference designation. For example, R6 on the A2 Meter Logic Assembly is listed as A2R6.

7-4. The Schematic Notes in Table 7-1 pertain to all the schematics. Additional notes on the schematics indicate test conditions, and special information for use when maintaining the instrument.

7-5. TROUBLESHOOTING.

7-6. Table 7-2 is the Overall Troubleshooting chart for the power meter. Procedures for isolating circuit malfunctions to specific stages are based on the use of the HP 8477A Power Meter Calibrator and the calibration procedures in Section V. The information obtained when calibration is attempted is used to troubleshoot the instrument.

7-7. Table 7-2 contains references that direct the user to the detailed troubleshooting charts, Tables 7-3 through 7-11. The detailed charts refer the user to transistor stages. In a few instances, specific parts are called out as being possible causes of circuit malfunction, however, the troubleshooting charts are not intended to locate specific parts that have failed. They are intended to locate only malfunctioning stages.

7-8. SCHEMATICS.

7-9. The schematics contain signal routing information, nominal voltage levels, and notes that assist in understanding the circuit. They are laid out to show electrical operation, and are not intended as wiring diagrams.

7-10. Component location photographs next to the schematic foldouts indicate the physical location of parts. Test points are also shown, and are marked on the schematic in the same manner as they are in the meter.

7-11. Factory selected parts are indicated by an asterisk. These are components that generally are installed to fulfill circuit operation requirements. They may be the nominal value, or they may be some value close to nominal. In any case, if the component fails, circuit operation should be verified after these components are replaced.

7-12. A1A1 AUTO ZERO ASSEMBLY.

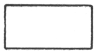
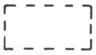
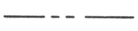
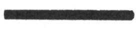
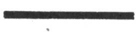
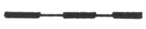
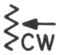
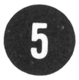
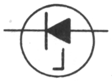
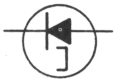
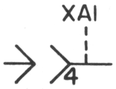
7-13. The Auto Zero circuit is encapsulated and must be replaced as a unit. A solder removing tool, such as the Soldapullit suction device listed in Section V, is required to remove solder around the leads. After solder is removed, the unit must be carefully removed from the circuit card in such a manner that the circuits on the card do not delaminate. After the Auto Zero assembly is replaced, perform the adjustment procedure given in Section V.

7-14. TEST CONDITIONS.

7-15. For most tests of circuit operation when troubleshooting the instrument, the troubleshooting charts call out control settings. In special cases, notes on the schematics indicate control settings required to measure voltage levels in circuits. Generally, the following control settings should be selected, and changed only as the troubleshooting procedures indicate:

RANGE	.3 mW (-5 dBm)
MOUNT RESISTANCE	200 (Mount installed)
CALIBRATION FACTOR	100
COARSE ZERO	turn until meter is at full scale

Table 7-1. Schematic Notes

1.		Resistance in ohms, capacitance in microfarads unless otherwise indicated.
2.		Screwdriver adjustment
		Front panel control
3.		Front panel designation
		Rear panel designation
4.		Printed circuit card border
		Main signal path
		Secondary signal path
		Secondary feedback path
5.		P/O = part of
6.		Wiper moves toward CW when control rotated clockwise
7.		Test point. Number in circle matches number on printed circuit card.
8.		Breakdown diode
9.		Tunnel diode
10.	947	Wire color code. Numerical color code same as resistor coding. For example, 947 denotes white, yellow, violet wire.
11.		Indicates socket connections and pin numbers.

TEST POINT MEASUREMENT CONDITIONS AND VOLTAGES

Measurement Conditions

1. .3 mW
2. 200 ohm mount
3. 100% CAL FACTOR
4. COARSE ZERO turned to get full-scale deflection
5. Measurements made with respect to CHASSIS GROUND

Test Point Voltages

Test Point	Voltage	Notes
A1TP1	+5.2	
A1TP2	+5.2	
A1TP3	+2.7	
A1TP4	+2.7	
A1TP5	+2.7	
A1TP6	+2.7	
A1TP7	+1.2	RANGE to COARSE ZERO, meter zeroed
A1TP8	-6.5	Varies from 0 to -13 V under normal operating conditions
A1TP9	+4 mV	Thermistor ground
A2TP1	Waveform	Figure 7-3
A2TP2	Waveform	Figure 7-3
A2TP3	+7 Nominal	
A2TP4	-13 Nominal	
A2TP5	0 V	Chassis Ground
A2TP6	Waveform	Figure 7-3
A2TP7	Waveform	Figure 7-3
A2TP8	Waveform	Figure 7-3
A2TP9	Waveform	Figure 7-3
A2TP10	Waveform	Figure 7-3
A7TP1	+1 Variable	
A7TP2	+1.6 Variable	

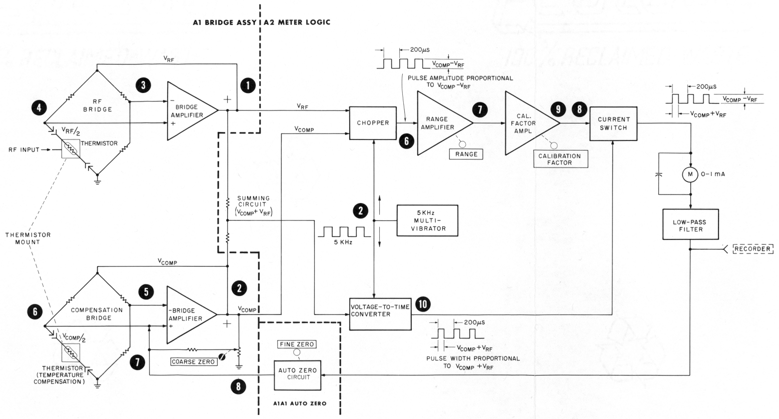

A1 BRIDGE ASSY
A2 METER LOGIC
V_{RF}
RF BRIDGE
BRIDGE AMPLIFIER
$V_{RF}/2$
THERMISTOR
RF INPUT
THERMISTOR MOUNT
SUMMING CIRCUIT ($V_{COMP}+V_{RF}$)
V_{COMP}
COMPENSATION BRIDGE
-BRIDGE AMPLIFIER
$V_{COMP}/2$
THERMISTOR (TEMPERATURE COMPENSATION)
COARSE ZERO
FINE ZERO
AUTO ZERO CIRCUIT
A1A1 AUTO ZERO
CHOPPER
5 KHz
5KHz MULTI-VIBRATOR
VOLTAGE-TO-TIME CONVERTER
200μs
$V_{COMP}-V_{RF}$
PULSE AMPLITUDE PROPORTIONAL TO $V_{COMP}-V_{RF}$
RANGE AMPLIFIER
RANGE
CAL. FACTOR AMPL
CALIBRATION FACTOR
CURRENT SWITCH
$V_{COMP}+V_{RF}$
PULSE WIDTH PROPORTIONAL TO $V_{COMP}+V_{RF}$
M
0-1 mA
LOW-PASS FILTER
RECORDER
1
2
3
4
5
6
7
8
9
10

Figure 7-1. Servicing Block Diagram

Figure 7-1
SERVICING BLOCK DIAGRAM

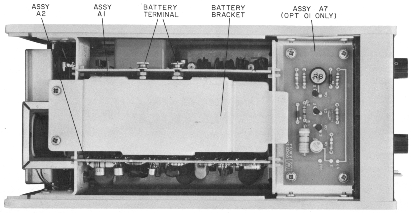

ASSY
A2
ASSY
A1
BATTERY
TERMINAL
BATTERY
BRACKET
ASSY A7
(OPT 01 ONLY)
R8

Figure 7-2. Model 432A Top Internal View

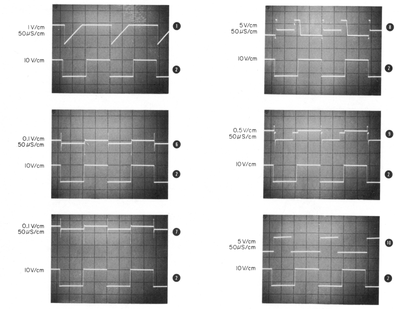
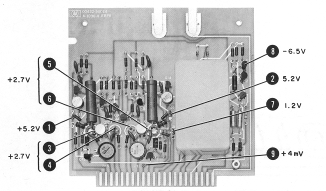
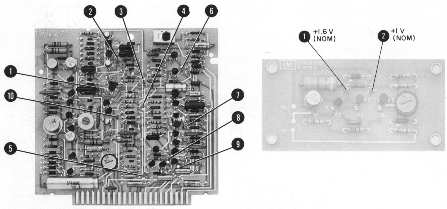


Figure 7-3. Model 432A Waveforms, A2 Meter Logic Assembly


+2.7V
+5.2V
+2.7V
5
6
1
3
4
8 -6.5V
2 5.2V
7 1.2V
9 +4mV

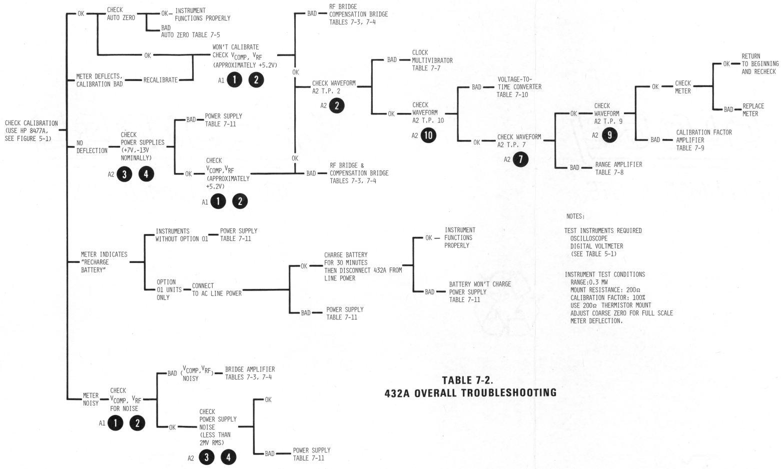
ASSY A1


2
3
4
6
1
10
5
7
8
9
1 +1.6V (NOM)
2 +1V (NOM)

ASSY A2

ASSY A7

Figure 7-4. Model 432A Test Point Locations


CHECK CALIBRATION
(USE HP 8477A,
SEE FIGURE 5-1)
OK
CHECK
AUTO ZERO
OK – INSTRUMENT
FUNCTIONS PROPERLY
BAD
AUTO ZERO TABLE 7-5
OK
WON'T CALIBRATE
CHECK V_{COMP}, V_{RF}
(APPROXIMATELY +5.2V)
A1 1 2
METER DEFLECTS,
CALIBRATION BAD
RECALIBRATE
BAD
RF BRIDGE
COMPENSATION BRIDGE
TABLES 7-3, 7-4
OK
CHECK WAVEFORM
A2 T.P. 2
A2 2
BAD
CLOCK
MULTIVIBRATOR
TABLE 7-7
OK
CHECK
WAVEFORM
A2 T.P. 10
A2 10
BAD
VOLTAGE-TO-
TIME CONVERTER
TABLE 7-10
OK
CHECK WAVEFORM
A2 T.P. 7
A2 7
OK
CHECK
WAVEFORM
A2 T.P. 9
A2 9
OK
CHECK
METER
OK
RETURN
TO BEGINNING
AND RECHECK
BAD
REPLACE
METER
BAD
CALIBRATION FACTOR
AMPLIFIER
TABLE 7-9
BAD
RANGE AMPLIFIER
TABLE 7-8
NO
DEFLECTION
CHECK
POWER SUPPLIES
(+7V,-13V
NOMINALLY)
A2 3 4
BAD
POWER SUPPLY
TABLE 7-11
OK
CHECK
V_{COMP}, V_{RF}
(APPROXIMATELY
+5.2V)
A1 1 2
OK
BAD
RF BRIDGE &
COMPENSATION BRIDGE
TABLES 7-3, 7-4
METER INDICATES
"RECHARGE
BATTERY"
INSTRUMENTS
WITHOUT OPTION 01
POWER SUPPLY
TABLE 7-11
OPTION
01 UNITS
ONLY
CONNECT
TO AC LINE POWER
OK
CHARGE BATTERY
FOR 30 MINUTES
THEN DISCONNECT 432A FROM
LINE POWER
OK – INSTRUMENT
FUNCTIONS
PROPERLY
BAD
BATTERY WON'T CHARGE
POWER SUPPLY
TABLE 7-11
BAD
POWER SUPPLY
TABLE 7-11
METER
NOISY
CHECK
V_{COMP}, V_{RF}
FOR NOISE
A1 1 2
BAD (V_{COMP}, V_{RF}) NOISY
BRIDGE AMPLIFIER
TABLES 7-3, 7-4
OK
CHECK
POWER SUPPLY
NOISE
(LESS THAN
2MV RMS)
A2 3 4
OK
BAD
POWER SUPPLY
TABLE 7-11

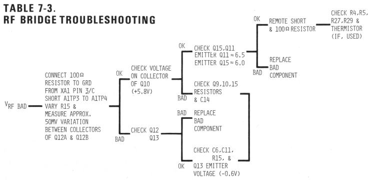
NOTES:

TEST INSTRUMENTS REQUIRED
OSCILLOSCOPE
DIGITAL VOLTMETER
(SEE TABLE 5-1)

INSTRUMENT TEST CONDITIONS
RANGE:0.3 MW
MOUNT RESISTANCE: 200Ω
CALIBRATION FACTOR: 100%
USE 200Ω THERMISTOR MOUNT
ADJUST COARSE ZERO FOR FULL SCALE
METER DEFLECTION.

TABLE 7-2.
432A OVERALL TROUBLESHOOTING

TABLE 7-3.
RF BRIDGE TROUBLESHOOTING


V_RF BAD
CONNECT 100Ω RESISTOR TO GRD FROM XA1 PIN 3/C SHORT A1TP3 TO A1TP4 VARY R15 & MEASURE APPROX. 50MV VARIATION BETWEEN COLLECTORS OF Q12A & Q12B
OK
CHECK VOLTAGE ON COLLECTOR OF Q10 (+5.8V)
BAD
CHECK Q12 Q13
OK
CHECK Q15,Q11 EMITTER Q11 ≈ 6.5 EMITTER Q15 ≈ 6.0
BAD
CHECK Q9,10,15 RESISTORS & C14
BAD
REPLACE BAD COMPONENT
OK
CHECK C6,C11, R15, & Q13 EMITTER VOLTAGE (-0.6V)
OK
REMOTE SHORT & 100Ω RESISTOR
CHECK R4,R5, R27,R29 & THERMISTOR (IF, USED)
BAD
REPLACE BAD COMPONENT

NOTE:IF TROUBLESHOOTING RF BRIDGE FOR NOISE, CHECK Q12.

TABLE 7-4.
COMPENSATION BRIDGE P/O A1 TROUBLESHOOTING

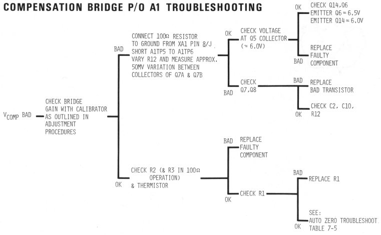

V_COMP BAD
CHECK BRIDGE GAIN WITH CALIBRATOR AS OUTLINED IN ADJUSTMENT PROCEDURES
BAD
CONNECT 100Ω RESISTOR TO GROUND FROM XA1 PIN 8/J SHORT A1TP5 TO A1TP6 VARY R12 AND MEASURE APPROX. 50MV VARIATION BETWEEN COLLECTORS OF Q7A & Q7B
OK
CHECK R2 (& R3 IN 100Ω OPERATION) & THERMISTOR
OK
CHECK VOLTAGE AT Q5 COLLECTOR (≈ 6.0V)
BAD
CHECK Q7,Q8
OK
CHECK Q14,Q6 EMITTER Q6 ≈ 6.5V EMITTER Q14 ≈ 6.0V
BAD
REPLACE FAULTY COMPONENT
BAD
REPLACE BAD TRANSISTOR
OK
CHECK C2, C10, R12
BAD
REPLACE FAULTY COMPONENT
OK
CHECK R1
BAD
REPLACE R1
OK
SEE: AUTO ZERO TROUBLESHOOT TABLE 7-5

Table 7-2
OVERALL TROUBLESHOOTING

TABLE 7-5.
AUTO ZERO CIRCUIT P/O A1 TROUBLESHOOTING

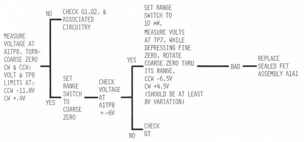
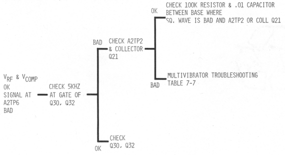

MEASURE VOLTAGE AT A1TP8. TURN-COARSE ZERO CW & CCW; VOLT @ TP8 LIMITS AT: CCW -11.8V CW +.4V
NO
CHECK Q1,Q2, & ASSOCIATED CIRCUITRY
YES
SET RANGE SWITCH TO COARSE ZERO
CHECK VOLTAGE AT A1TP8 ≈ -6V
YES
SET RANGE SWITCH TO 10 mW. MEASURE VOLTS AT TP7, WHILE DEPRESSING FINE ZERO, ROTATE COARSE ZERO THRU ITS RANGE. CCW -6.5V CW +4.5V (SHOULD BE AT LEAST 8V VARIATION)
BAD
REPLACE SEALED FET ASSEMBLY A1A1
NO
CHECK Q3

TABLE 7-6.
CHOPPER P/O A2 TROUBLESHOOTING


V_{RF} & V_{COMP} OK SIGNAL AT A2TP6 BAD
CHECK 5KHZ AT GATE OF Q30, Q32
BAD
CHECK A2TP2 & COLLECTOR Q21
OK
CHECK 100K RESISTOR & .01 CAPACITOR BETWEEN BASE WHERE SQ. WAVE IS BAD AND A2TP2 OR COLL Q21
BAD
MULTIVIBRATOR TROUBLESHOOTING TABLE 7-7
OK
CHECK Q30, Q32

SERVICE HINT: IF TROUBLESHOOTING CHOPPER FOR NOISE, LIFT END OF C29 & C31 AND SEE IF NOISE PERSISTS.

TABLE 7-7.
MULTIVIBRATOR P/O A2 TROUBLESHOOTING

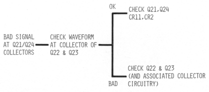

BAD SIGNAL AT Q21/Q24 COLLECTORS
CHECK WAVEFORM AT COLLECTOR OF Q22 & Q23
OK
CHECK Q21,Q24 CR11,CR2
BAD
CHECK Q22 & Q23 (AND ASSOCIATED COLLECTOR CIRCUITRY)

TABLE 7-8.
RANGE AMPLIFIER TROUBLESHOOTING

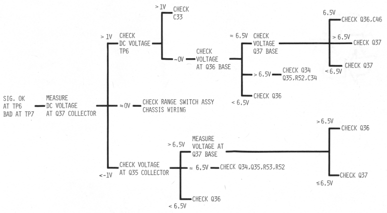
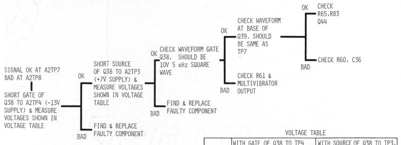

SIG. OK AT TP6 BAD AT TP7
MEASURE DC VOLTAGE AT Q37 COLLECTOR
> 1V
CHECK DC VOLTAGE TP6
> 1V
CHECK C33
~0V
CHECK VOLTAGE AT Q36 BASE
≈ 6.5V
CHECK VOLTAGE Q37 BASE
6.5V
CHECK Q36,C46
> 6.5V
CHECK Q37
< 6.5V
CHECK Q37
> 6.5V
CHECK Q34 Q35,R52,C34
< 6.5V
CHECK Q36
≈0V
CHECK RANGE SWITCH ASSY CHASSIS WIRING
<-1V
CHECK VOLTAGE AT Q35 COLLECTOR
> 6.5V
MEASURE VOLTAGE AT Q37 BASE
> 6.5V
CHECK Q36
≤6.5V
CHECK Q37
≈ 6.5V
CHECK Q34,Q35,R53,R52
< 6.5V
CHECK Q36

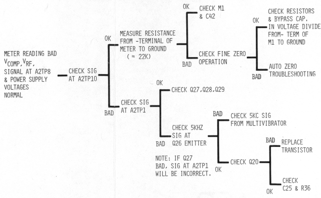
TABLE 7-9.
CALIBRATION FACTOR AMPLIFIER P/O A2 TROUBLESHOOTING


SIGNAL OK AT A2TP7 BAD AT A2TP8
SHORT GATE OF Q38 TO A2TP4 (-13V SUPPLY) & MEASURE VOLTAGES SHOWN IN VOLTAGE TABLE
OK
SHORT SOURCE OF Q38 TO A2TP3 (+7V SUPPLY) & MEASURE VOLTAGES SHOWN IN VOLTAGE TABLE
OK
CHECK WAVEFORM GATE Q38. SHOULD BE 10V 5 kHz SQUARE WAVE
OK
CHECK WAVEFORM AT BASE OF Q39. SHOULD BE SAME AS TP7
OK
CHECK R65,R83 Q44
BAD
CHECK R60, C36
BAD
CHECK R61 & MULTIVIBRATOR OUTPUT
BAD
FIND & REPLACE FAULTY COMPONENT
BAD
FIND & REPLACE FAULTY COMPONENT

VOLTAGE TABLE

POINT	WITH GATE OF Q38 TO TP4		WITH SOURCE OF Q38 TO TP3.	
	VOLTAGE	IF BAD, CHECK	VOLTAGE	IF BAD,REPLACE
BASE,Q39	~ 0V	Q38,C38,R63	+6.1V	Q39,C36
BASE,Q40	~+.4V	A4 ASSY,CHASSIS WIRING	~ 0V	Q40
BASE,Q41	+6.83V	Q39,Q41,R77,C39	+6.2V	Q39,Q41
BASE,Q42	+5.47V	Q41	+6.8V	Q41,
TP8	+6.15V	Q4,Q43	0.7V	Q42,Q43

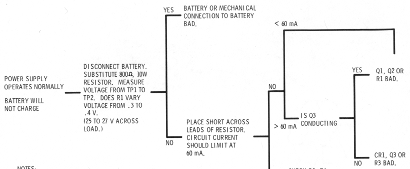
TABLE 7-10.
VOLTAGE-TO-TIME CONVERTER & METER TROUBLESHOOTING


METER READING BAD V_{COMP},V_{RF}, SIGNAL AT A2TP8 & POWER SUPPLY VOLTAGES NORMAL
CHECK SIG AT A2TP10
OK
MEASURE RESISTANCE FROM -TERMINAL OF METER TO GROUND (≈ 22K)
OK
CHECK M1 & C42
BAD
CHECK FINE ZERO OPERATION
OK
CHECK RESISTORS & BYPASS CAP. IN VOLTAGE DIVIDER FROM- TERM OF M1 TO GROUND
BAD
AUTO ZERO TROUBLESHOOTING
BAD
CHECK SIG AT A2TP1
OK
CHECK Q27,Q28,Q29
BAD
CHECK 5KHZ SIG AT Q26 EMITTER
BAD
CHECK 5KC SIG FROM MULTIVIBRATOR
OK
CHECK Q20
BAD
REPLACE TRANSISTOR
OK
CHECK C25 & R36

NOTE: IF Q27 BAD, SIG AT A2TP1 WILL BE INCORRECT.

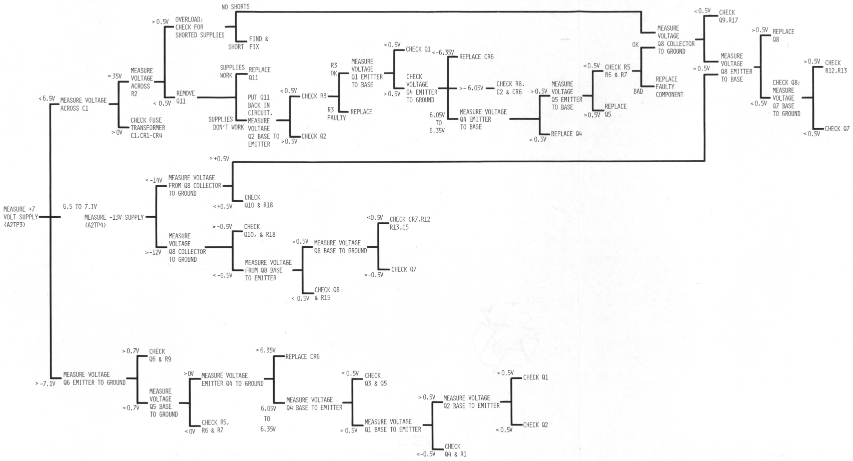
◀ TROUBLESHOOTING
TABLES 7-3 THROUGH 7-10

TABLE 7-11.
BATTERY CHARGER TROUBLESHOOTING


POWER SUPPLY OPERATES NORMALLY
BATTERY WILL NOT CHARGE
DISCONNECT BATTERY. SUBSTITUTE 800Ω, 10W RESISTOR. MEASURE VOLTAGE FROM TP1 TO TP2. DOES R1 VARY VOLTAGE FROM .3 TO .4 V. (25 TO 27 V ACROSS LOAD.)
YES
BATTERY OR MECHANICAL CONNECTION TO BATTERY BAD.
NO
PLACE SHORT ACROSS LEADS OF RESISTOR. CIRCUIT CURRENT SHOULD LIMIT AT 60 mA.
NO
< 60 mA
> 60 mA
IS Q3 CONDUCTING
YES
Q1, Q2 OR R1 BAD.
NO
CR1, Q3 OR R3 BAD.
YES
CHECK Q4, R6, R7, R8 AND ASSOCIATED CIRCUITRY.

NOTES:
1. USE FLOATING DVM.
2. R8 NORMALLY AFFECTS CURRENT NEAR CW EXTREME.

TABLE 7-12.
POWER SUPPLY TROUBLESHOOTING


MEASURE +7 VOLT SUPPLY (A2TP3)
<6.5V
MEASURE VOLTAGE ACROSS C1
≈35V
MEASURE VOLTAGE ACROSS R2
>0.5V
OVERLOAD; CHECK FOR SHORTED SUPPLIES
NO SHORTS
SHORT
FIND & FIX
<0.5V
REMOVE Q11
SUPPLIES WORK
REPLACE Q11
SUPPLIES DON'T WORK
PUT Q11 BACK IN CIRCUIT. MEASURE VOLTAGE Q2 BASE TO EMITTER
<0.5V
CHECK R3
R3 OK
R3 FAULTY
REPLACE
>0.5V
CHECK Q2
MEASURE VOLTAGE Q1 EMITTER TO BASE
<0.5V
CHECK Q1
>0.5V
CHECK VOLTAGE Q4 EMITTER TO GROUND
<-6.35V
REPLACE CR6
>-6.05V
CHECK R8, C2 & CR6
6.05V TO 6.35V
MEASURE VOLTAGE Q4 EMITTER TO BASE
>0.5V
MEASURE VOLTAGE Q5 EMITTER TO BASE
<0.5V
CHECK R5 R6 & R7
>0.5V
REPLACE Q5
<0.5V
REPLACE Q4
MEASURE VOLTAGE Q8 COLLECTOR TO GROUND
OK
BAD
REPLACE FAULTY COMPONENT
<0.5V
CHECK Q9,R17
>0.5V
MEASURE VOLTAGE Q8 EMITTER TO BASE
>0.5V
REPLACE Q8
<0.5V
CHECK Q8; MEASURE VOLTAGE Q7 BASE TO GROUND
>0.5V
CHECK R12,R13
<0.5V
CHECK Q7
>0V
CHECK FUSE TRANSFORMER C1,CR1-CR4
6.5 TO 7.1V
MEASURE -13V SUPPLY (A2TP4)
<-14V
MEASURE VOLTAGE FROM Q8 COLLECTOR TO GROUND
>+0.5V
<+0.5V
CHECK Q10 & R18
>-12V
MEASURE VOLTAGE Q8 COLLECTOR TO GROUND
>-0.5V
CHECK Q10, & R18
<-0.5V
MEASURE VOLTAGE FROM Q8 BASE TO EMITTER
>0.5V
MEASURE VOLTAGE Q8 BASE TO GROUND
<0.5V
CHECK CR7,R12 R13,C5
>-0.5V
CHECK Q7
< 0.5V
CHECK Q8 & R15
>-7.1V
MEASURE VOLTAGE Q6 EMITTER TO GROUND
>0.7V
CHECK Q6 & R9
<0.7V
MEASURE VOLTAGE Q5 BASE TO GROUND
>0V
MEASURE VOLTAGE EMITTER Q4 TO GROUND
<0V
CHECK R5, R6 & R7
>6.35V
REPLACE CR6
6.05V TO 6.35V
MEASURE VOLTAGE Q4 BASE TO EMITTER
<0.5V
CHECK Q3 & Q5
>0.5V
MEASURE VOLTAGE Q1 BASE TO EMITTER
>0.5V
MEASURE VOLTAGE Q2 BASE TO EMITTER
>0.5V
CHECK Q1
<0.5V
CHECK Q2
<-0.5V
CHECK Q4 & R1

TROUBLESHOOTING
TABLES 7-11 THROUGH 7-12

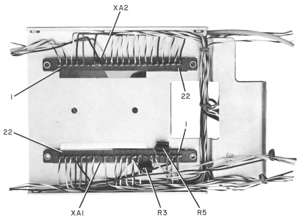

XA2
1
22
22
1
XA1
R3
R5

Figure 7-5. 432A Bottom View, Component Locations

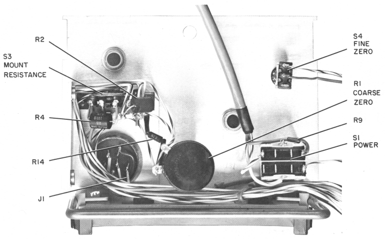

R2
S3
MOUNT
RESISTANCE
R4
R14
J1
S4
FINE
ZERO
R1
COARSE
ZERO
R9
S1
POWER

Figure 7-6. 432A Front Panel Interior

**ADDED FOR LONG CABLE OPTIONS (11, 12)

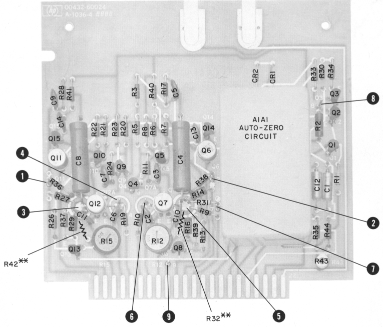

00432-60024
A-1036-4
C9
R28
R41
R3
R40
R17
C5
CR2
CR1
R33
R30
R34
Q3
Q2
C14
Q15
R22
R21
R23
R20
R5
R8
R6
R7
C13
Q14
A1A1
AUTO-ZERO
CIRCUIT
R2
Q1
Q11
C8
Q10
Q9
R24
C7
Q4
R11
Q5
C3
C4
Q6
R36
R27
Q12
Q7
R38
R14
R31
R9
C12
C1
R1
C11
C6
R19
R10
C2
C10
R16
R39
R13
R26
R37
R29
R15
R12
Q8
R35
R44
R43
Q13
R42**
R32**
1
2
3
4
5
6
7
8
9

Figure 7-7. A1 Bridge Assembly Component Locations

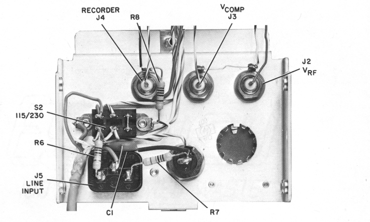
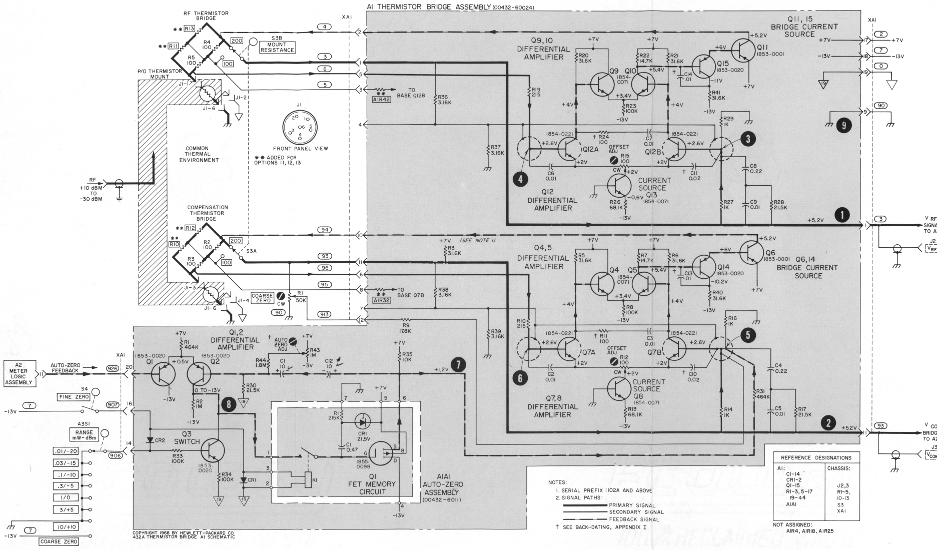

RECORDER
J4
R8
V_{COMP}
J3
J2
V_{RF}
S2
115/230
R6
J5
LINE
INPUT
C1
R7

Figure 7-8. 432A Rear Panel Interior


A1 THERMISTOR BRIDGE ASSEMBLY (00432-60024)
RF THERMISTOR BRIDGE
**R13
**R11
R4 100
R5 100
200
100
S3B
MOUNT RESISTANCE
P/O THERMISTOR MOUNT
J1-1
J1-2
J1-6
J1
FRONT PANEL VIEW
** ADDED FOR OPTIONS 11, 12, 13
COMMON THERMAL ENVIRONMENT
RF
+10 dBM TO -30 dBM
COMPENSATION THERMISTOR BRIDGE
**R12
**R10
R2 100
R3 100
S3A
J1-3
J1-4
COARSE ZERO
CW
R1 50K
XA1
TO BASE Q12B
AIR42
TO BASE Q7B
AIR32
R36 3.16K
R37 3.16K
R38 3.16K
R39 3.16K
R3 31.6K
R9 17.8K
(SEE NOTE 1)
Q9, 10
DIFFERENTIAL AMPLIFIER
R20 31.6K
R22 14.7K
R21 31.6K
Q9
Q10
1854-0071
+5.4V
+3.4V
R23 100K
-13V
+4V
R19 215
Q11, 15
BRIDGE CURRENT SOURCE
Q11 1853-0001
Q15 1853-0020
+5.2V
+6V
-11V
+7V
C14 .01
R41 31.6K
R29 1K
Q12A
Q12B
1854-0221
+2.6V
+2V
R24 100
C7 0.01
OFFSET ADJ
R15 100
C6 0.01
C11 0.02
C8 0.22
CURRENT SOURCE
Q13 1854-0071
R26 68.1K
-0.6V
Q12
DIFFERENTIAL AMPLIFIER
R27 1K
C9 0.01
R28 21.5K
+5.2V
V_{RF} BRIDGE SIGNAL TO A2 ASSY
J2
V_{RF}
Q4, 5
DIFFERENTIAL AMPLIFIER
R5 31.6K
R7 14.7K
R6 31.6K
Q4
Q5
R8 100K
Q6 1853-0001
Q14 1853-0020
Q6, 14
BRIDGE CURRENT SOURCE
C13 .01
-10.2V
R40 31.6K
R16 1K
R10 215
Q7A
Q7B
R11 100
C3 0.01
R12 100
C2 0.01
C10 0.02
C4 0.22
CURRENT SOURCE
Q8 1854-0071
R13 68.1K
Q7, 8
DIFFERENTIAL AMPLIFIER
R14 1K
R31 464K
C5 0.01
R17 21.5K
+5.2V
$V_{COMPENSATION}$ BRIDGE SIGNAL TO A2 ASSY
J3
V_{COMP}
A2 METER LOGIC ASSEMBLY
AUTO-ZERO FEEDBACK
Q1, 2
DIFFERENTIAL AMPLIFIER
Q1
Q2
1853-0020
R1 464K
+0.5V
0 TO -13V
R2 1M
AUTO ZERO ADJ
R43 1M
R44 1.8M
C1 10
C12 10
R30 21.5K
R35 10K
+1.2V
S4
FINE ZERO
A3S1
RANGE mW-dBm
.01/-20
.03/-15
.1/-10
.3/-5
1/0
3/+5
10/+10
COARSE ZERO
CR2
Q3
SWITCH
R33 100K
1853-0020
R34 100K
CR1
R1 215K
CR1 21.5V
C1 0.47
K1
Q1 1855-0098
FET MEMORY CIRCUIT
A1A1
AUTO-ZERO ASSEMBLY (00432-60111)
1
2
3
4
5
6
7
8
9

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432A THERMISTOR BRIDGE A1 SCHEMATIC

NOTES:
1. SERIAL PREFIX 1102A AND ABOVE
2. SIGNAL PATHS:
PRIMARY SIGNAL
SECONDARY SIGNAL
FEEDBACK SIGNAL
† SEE BACK-DATING, APPENDIX I

REFERENCE DESIGNATIONS	
A1:	CHASSIS:
C1-14 CR1-2 Q1-15 R1-3, 5-17 19-44 A1A1	J2,3 R1-5, 10-13 S3 XA1

NOT ASSIGNED:
A1R4, A1R18, A1R25

1

* 7"6"

Figure 7-9. RF and Compensation Bridge Schematic

Figure 7-9

RF AND COMPENSATION BRIDGE SCHEMATIC

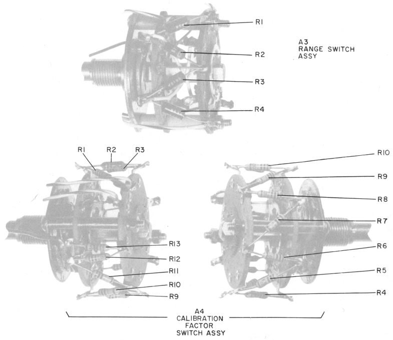

R1
R2
R3
R4
A3
RANGE SWITCH
ASSY
R1
R2
R3
R13
R12
R11
R10
R9
R10
R9
R8
R7
R6
R5
R4
A4
CALIBRATION
FACTOR
SWITCH ASSY

Figure 7-10, Model 432A Switches

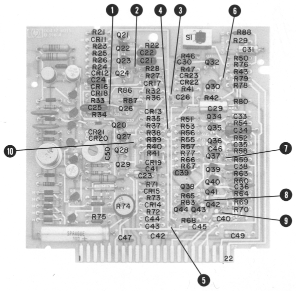
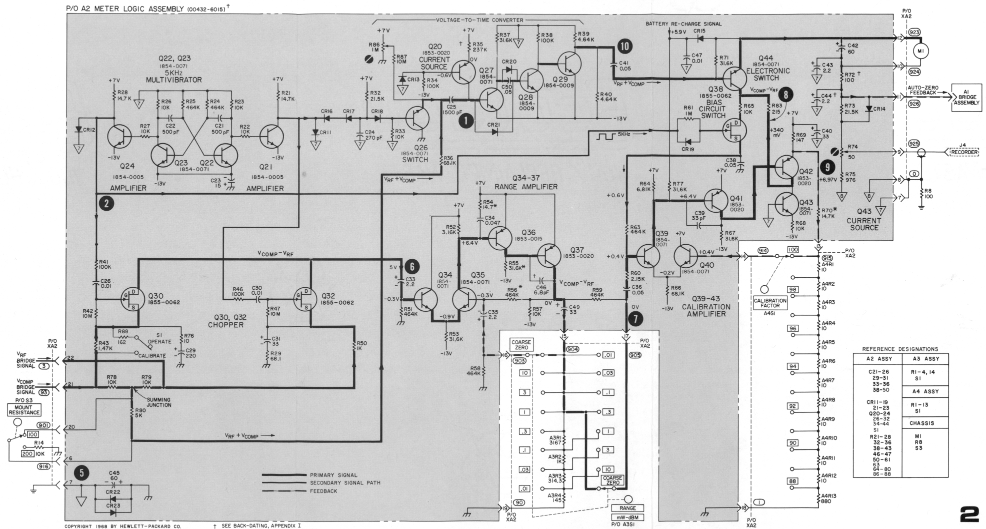

①
②
④
③
⑥
⑩
⑦
⑧
⑨
⑤
S1
R21 CR11 R23 R25 R26 R24 CR12 C24 CR16 CR18 R33 C25 R34
Q21 Q22 Q23 Q24 R66 R87 Q26
R22 C22 C21 R28 R27 CR17 R32 R36
R46 C30 R47 CR23 CR22 R41 C26
Q32 Q30 R42
R88 R29 C31 R50 R76 R45 R79 R78 R80
CR21 CR20 Q20 Q27 Q28 Q29
R13 R35 R37 R38 R39 R40 R41 CR19 C41 C23 R71 CR15 R73 CR14 R72 C44 C43
R51 R53 R56 R55 R57 R77 R66 R67 C39
C29 Q34 Q35 Q36 C46 Q37 Q39 Q40 Q41 Q42 Q38 R65 R83 Q44 Q43 R68 C45
C33 R54 C34 R52 C35 R58 R59 C38 R63 R60 C36 R64 R69 R70 C40
R74 R75 C47 C42 C49
1 22

Figure 7-11. A2 Meter Logic Assembly Component Locations


P/O A2 METER LOGIC ASSEMBLY (00432-60015)†
VOLTAGE-TO-TIME CONVERTER
Q22, Q23 1854-0071 5KHz MULTIVIBRATOR
Q24 1854-0005 AMPLIFIER
Q21 1854-0005 AMPLIFIER
Q20 1853-0020 CURRENT SOURCE
Q26 1854-0071 SWITCH
Q27 1854-0071
Q28 1854-0009
Q29 1854-0009
BATTERY RE-CHARGE SIGNAL
Q44 1854-0071 ELECTRONIC SWITCH
Q38 1855-0062 BIAS CIRCUIT SWITCH
Q34-37 RANGE AMPLIFIER
Q30 1855-0062
Q32 1855-0062
Q30, Q32 CHOPPER
Q39-43 CALIBRATION AMPLIFIER
Q43 CURRENT SOURCE
Q41 1853-0020
Q42 1853-0020
Q40 1854-0071
VRF + VCOMP
VCOMP - VRF
VRF BRIDGE SIGNAL
VCOMP BRIDGE SIGNAL
P/O S3 MOUNT RESISTANCE
SUMMING JUNCTION
S1 OPERATE CALIBRATE
COARSE ZERO
RANGE
mW-dBm
P/O A3S1
CALIBRATION FACTOR A4S1
AUTO-ZERO FEEDBACK
A1 BRIDGE ASSEMBLY
J4 RECORDER
M1
P/O XA2
PRIMARY SIGNAL
SECONDARY SIGNAL PATH
FEEDBACK
① ② ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

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432A METER LOGIC ASSY A2 SERIAL PREFIX 957-

† SEE BACK-DATING, APPENDIX I

REFERENCE DESIGNATIONS

A2 ASSY	A3 ASSY
C21-26 29-31 33-36 38-50 CR11-19 21-23 Q20-24 26-32 34-44 S1 R21-28 32-36 38-43 46-47 50-61 63 64-80 86-88	R1-4, 14 S1
	A4 ASSY
	R1-13 S1
	CHASSIS
	M1 R8 S3

2

Figure 7-12. Meter Logic Schematic

◀ Figure 7-12

METER LOGIC SCHEMATIC

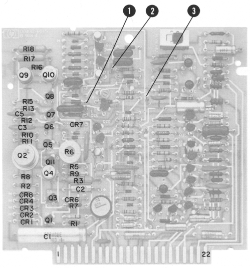

❶
❷
❸
R18
R17
R16
Q9
Q10
Q8
R15
R13
C5
Q7
R12
C3
Q6
CR7
R10
R11
Q5
R6
Q2
Q11
Q4
R5
R9
R8
R3
R2
C2
CR8
CR4
Q3
CR6
CR3
R7
CR2
CR1
Q1
R1
C1
1
22

Figure 7-13. A2 Meter Logic Assembly, Power Supply Component Locations

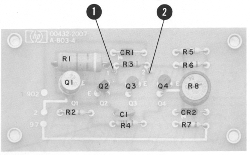
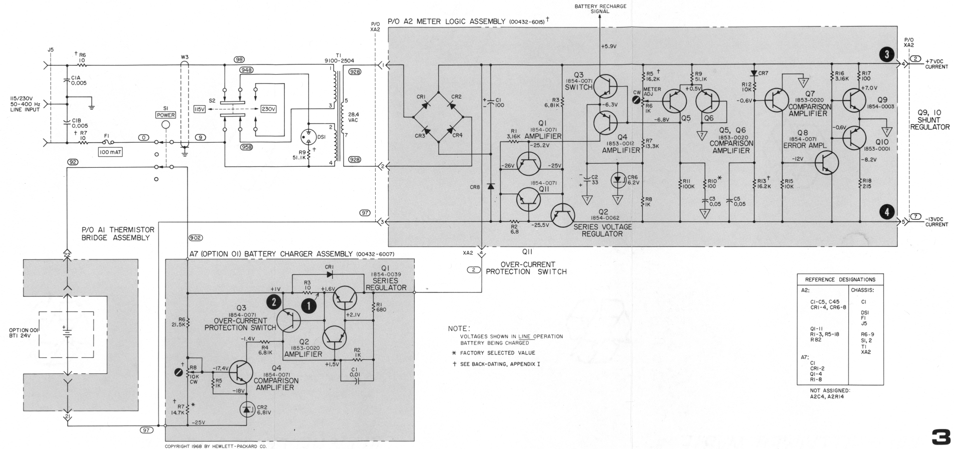

❶
❷
R1
CR1
R5
R3
R6
Q1
Q2
Q3
Q4
R8
R2
C1
CR2
R4
R7

Figure 7-14. A7 Battery Charging Circuit (Option 01), Component Locations


BATTERY RECHARGE SIGNAL
P/O A2 METER LOGIC ASSEMBLY (00432-6015)†
P/O XA2
J5
115/230V 50-400 Hz LINE INPUT
C1A 0.005
C1B 0.005
R6 10
R7 10
F1
100 MAT
W3
S1 POWER
S2
115V
230V
T1 9100-2504
28.4 VAC
DS1
R9 51.1K
CR1
CR2
CR3
CR4
CR8
C1 100
Q3 1854-0071 SWITCH
R3 6.81K
Q1 1854-0071 AMPLIFIER
R1 3.16K
Q11 1854-0071
Q2 1854-0062 SERIES VOLTAGE REGULATOR
R2 6.8
Q4 1853-0012 AMPLIFIER
R7 13.3K
C2 33
CR6 6.2V
R8 1K
R5 16.2K
METER ADJ
R6 1K
R9 51.1K
Q5
Q6
Q5, Q6 1853-0020 COMPARISON AMPLIFIER
R11 100K
R10 100
C3 0.05
C5 0.05
CR7
R12 10K
R13 16.2K
R15 10K
Q7 1853-0020 COMPARISON AMPLIFIER
Q8 1854-0071 ERROR AMPL
R16 3.16K
R17 100
Q9 1854-0003
Q10 1853-0001
R18 215
Q9, 10 SHUNT REGULATOR
+7VDC CURRENT
-13VDC CURRENT
❸
❹
XA2
Q11
OVER-CURRENT PROTECTION SWITCH
P/O A1 THERMISTOR BRIDGE ASSEMBLY
OPTION 001 BT1 24V
A7 (OPTION 01) BATTERY CHARGER ASSEMBLY (00432-6007)
CR1
R3 10
Q1 1854-0039 SERIES REGULATOR
R1 680
Q3 1854-0071 OVER-CURRENT PROTECTION SWITCH
❷
❶
R6 21.5K
R4 6.81K
Q2 1853-0020 AMPLIFIER
R2 1K
C1 0.01
R8 10K CW
R5 1K
Q4 1854-0071 COMPARISON AMPLIFIER
R7 14.7K
CR2 6.81V
-25V

NOTE:
VOLTAGES SHOWN IN LINE OPERATION
BATTERY BEING CHARGED

* FACTORY SELECTED VALUE

† SEE BACK-DATING, APPENDIX I

REFERENCE DESIGNATIONS	
A2:	CHASSIS:
C1-C5, C45 CR1-4, CR6-8	C1 DS1 F1 J5
Q1-11 R1-3, R5-18 R82	R6-9 S1, 2 T1 XA2
A7: C1 CR1-2 Q1-4 R1-8	

NOT ASSIGNED:
A2C4, A2R14

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432A THERM. BR., BATT. & METER LOGIC ASSY

Figure 7-15. Power Supply Schematic

Figure 7-15
POWER SUPPLY SCHEMATIC

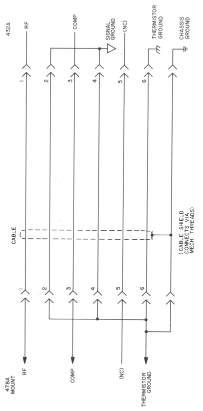

432A
RF
COMP
SIGNAL GROUND
(NC)
THERMISTOR GROUND
CHASSIS GROUND
1
2
3
4
5
6
CABLE
(CABLE SHIELD CONNECTS VIA MECH. THREADS)
478A MOUNT
RF
COMP
(NC)
THERMISTOR GROUND

Figure 7-16. Thermistor Cable Wiring Diagram

APPENDIX I
MANUAL CHANGES
(BACKDATING)

AI-1. INTRODUCTION

AI-2. This appendix contains information for adapting this manual to instruments for which the content does not directly apply.

AI-3. To adapt this manual to your instrument, refer to Table AI-1 and make all the changes listed opposite your instrument serial number. Perform these changes in the sequence listed.

AI-4. If your instrument serial number is not listed on the title page of this manual (or in Table 7-1), it may be documented in a MANUAL CHANGES supplement. For additional information about serial number coverage, refer to INSTRUMENT IDENTIFICATION in Section I.

AI-5. CHANGE INSTRUCTIONS

CHANGE A

Table 6-1 and Service Sheet 2:
Change A2C24 to 0140-0198 C:FXD 200 PF.
Delete A2C48.
Change A2R61-63 to 0698-3260 R:FXD MET FLM 464K OHM 1% 1/8W.

CHANGE B

Table 6-1 and Service Sheet 2:
Delete A2C49 (Junction of R57 and R59 connects directly to XA2-15).
Delete A2R29 (C31 connects directly to ground).

CHANGE C

Table 6-1:
Replace portion dealing with A2 Meter Logic Assy with Table A1-3.

Service Sheet 2:
Replace with Figure A1-1.

Figures 7-11 and 7-13:
Replace with Figures A1-2 and A1-3.

Table 6-1 and Service Sheet 1:
Change A1C13,14 to 0160-2264 C:FXD 20 PF 500 VDCW.

CHANGE D

Figure 4-4:
Delete reference to A2S1.

Paragraphs 5-16, 5-18 and 5-37:
Delete references to A2S1.

Table 6-1 and Service Sheet 2:
Delete A2R88 and A2S1.

CHANGE E

Table 6-1 and Service Sheet 3:
Change A7A7 to 0757-0199 R:FXD MET FLM 21.5K OHM 1% 1/8W.
Change A7R8 to 2100-1775 R:VAR WW 5K OHM 5% TYPE H 1W.

CHANGE F

Table 6-1 and Service Sheets 2 and 3
Change A2C46 to 0150-0059 C:FXD CER 3.3 ±0.25 PF 500 VCDW.
Change A2R5,13 to 0698-3156 R:FXD MET FLM 14.7 OHM 1% 1/8W.
Change A2R35 to 0698-3454 R:FXD MET FLM 215K OHM 1% 1/8W.

CHANGE G

Table 6-1 and Service Sheet 3:
Change F1 to 2100-0027 FUSE 125 MA 250V.
Change W2 to 8120-0078 CABLE ASSY: POWER CORD.
Change S2 to 3101-0033 SWITCH: SLIDE DPDT 0.5A 125V AC/DC.
Change J5 to 1261-0148 CONNECTOR: POWER 3 PIN MALE.

NOTE

To order a replacement rear panel, order the following parts (use current part numbers for S2 and J5):
00432-00022 PANEL: REAR
F1 2110-0234 FUSE 100 MA SLOW BLO 250V
W2 8120-1348 CABLE ASSY: POWER CORD

Figure 7-8:
Replace with Figure A1-4.

CHANGE H

Table 6-1 and Service Sheet 1:

Change A1C10,11 to 0160-2930 C:FXD CER .01 UF +80-20% 100 VWDC.

Table AI-1. Manual Changes

Serial Prefix or Number	Make Manual Changes
812-00200 and below	L,K,J,I,H,G,F,E,D,C,B,A
812-00201 to 00225, 840-	L,K,J,I,H,G,F,E,D,C,B
843-	L,K,J,I,H,G,F,E,D,C
904-, 919-,	L,K,J,I,H,G,F,E,D
937-01751 to 01850	L,K,J,I,H,G,F,E
937-01851 to 02950	L,K,J,I,H,G,F
937-02951 to 03050	L,K,J,I,H,G
968-03051 to 03550	L,K,J,I,H
968-03551 to 03650	L,K,J,I
992-	L,K,J
1102A04551 to 04650	L,K
1102A04651 to 06050	L

Table AI-2. Summary of Changes by Component

Change	A1	A2	A3	A4	A5	A6	A7	Chassis
A		C24, 48[3] R61-63						
B		C49[3] R29						
C	C13,14[1]							A2[4]
D		R88[1] S1						
E							R7,8[3]	
F		C46[1] R5,13,35						
G								F1,J5[1] S2,W2 Rear Panel
H	C10,11[2] R11, 24							
I								DS1,[1] R9 S1,3 Front Panel
J								A1[2]
K		C44[1] R72						
L								R6,7[2]

[1] Orginal part is preferred replacement.

[2] New part is preferred replacement.

[3] Modification to new part is recommended.

[4] Modification to new part is recommended (must also use Modification Kit 00432-6023).

Change A1R11, 24 to 0757-0416 R:FXD MET FLM 511 OHM 1% 1/8W.

CHANGE I

Table 6-1 and Service Sheet 3:
Change DS1 to 2140-0015 LAMP: GLOW NEON NE2H.
Change R9 to 0698-3160 R:FXD MET FLM 31.6K OHM 1% 1/8W.
Change S1 to 3010-0957 SWITCH: TOGGLE DPDT.
Change S3 to 3101-1180 SWITCH: SLIDE 3 PDT.
Add: XDS1 5040-0235 BASE: LAMPHOLDER.
XDS1 5040-257 LAMPHOLDER
00432-0003 PLATE: SWITCH
0590-0041 NUT: KNURLED

NOTE

To order a replacement front panel, order the following parts:
00432-0021 PANEL: FRONT(LIGHT GRAY)
S1 3101-1394 SWITCH: PUSHBUTTON
R9 0757-0458 R:FXD MET FLM 51.1K OHM 1% 1/8W
DS1 2140-0244 LAMP: GLOW 95V
S3 3100-2485 SWITCH: LEVER 4 PDT
00432-00031 PLATE: SWITCH
0370-0432 KNOB: LEVER

Figure 7-6:
Replace with Figure A1-5.

CHANGE J

Figure 4-3:
Delete reference to A1R43,44.

Table 6-1 and Service Sheet 1:
Change A1 to 00432-6001 BOARD ASSY: BRIDGE
Delete A1R43,44.

CHANGE K

Table 6-1 and Service Sheet 2:
Change A2C44 to 0180-0291 C:FXD ELECT 1.0 UF 10% 35 VDCW.
Change A2R72 to 0698-3444 R:FXD 316 OHM 1% 1/2W.

CHANGE L

Table 6-1 and Service Sheet 3:
Change R6 and R7 to 0757-0198 R:FXD MET FLM 100 OHM 1% 1/8W.

Table AI-3. Back-dating for Table 6-1 (Change C)

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A2	00432-6002	2	BOARD ASSY:LOGIC	28480	00432-6002
A2C1	0180-1819	1	C:FXD ELECT 100 UF +75-10% 50VDCW	28480	0180-1819
A2C2	0180-0229	2	C:FXD ELECT 33 UF 10% 10VDCW	28480	0180-0229
A2C3	0160-2917	6	C:FXD CER 0.05 UF +80-20% 100VDCW	84411	TYPE TA
A2C4	0160-2917		C:FXD CER 0.05 UF +80-20% 100VDCW	84411	TYPE TA
A2C4			FACTORY SELECTED PART		
A2C5	0160-2917		C:FXD CER 0.05 UF +80-20% 100VDCW	84411	TYPE TA
A2C6			NOT ASSIGNED		
A2C20			NOT ASSIGNED		
A2C21	0140-0234	2	C:FXD MICA 500 PF 1%	28480	0140-0234
A2C22	0140-0234		C:FXD MICA 500 PF 1%	28480	0140-0234
A2C23	0180-1746	1	C:FXD ELECT 15 UF 10% 20VDCW	28480	0180-1746
A2C24	0140-0198	1	C:FXD MICA 200 PF 5%	72136	RDM15F201J3C
A2C25	0160-0978	1	C:FXD MICA 1500 PF 1% 500VDCW	28480	0160-0978
A2C26	0160-2930	5	C:FXD CER 0.01 UF +80-20% 100VDCW	91418	TA
A2C27			NOT ASSIGNED		
A2C28	0160-2930		C:FXD CER 0.01 UF +80-20% 100VDCW	91418	TA
A2C29	0180-2178	1	C:FXD ELECT 220 UF 20% 8VDCW	56289	109D227X0008F2-DYP
A2C30	0160-2930		C:FXD CER 0.01 UF +80-20% 100VDCW	91418	TA
A2C31	0180-1940	1	C:FXD ELECT 33 UF 10% 15VDCW	56289	109D336X9015C2-DYP
A2C32	0160-2930		C:FXD CER 0.01 UF +80-20% 100VDCW	91418	TA
A2C33	0180-0197	4	C:FXD ELECT 2.2 UF 10% 20VDCW	56289	150D225X9020A2-DYS
A2C34	0160-2672	1	C:FXD MY 0.047 UF 5% 80VDCW	28480	0160-2672
A2C35	0180-0197		C:FXD ELECT 2.2 UF 10% 20VDCW	56289	150D225X9020A2-DYS
A2C36	0160-2917		C:FXD CER 0.05 UF +80-20% 100VDCW	84411	TYPE TA
A2C37	0160-2143	1	C:FXD CER 2000 PF +80-20% 1000VDCW	91418	TYPE B
A2C38	0160-2917		C:FXD CER 0.05 UF +80-20% 100VDCW	84411	TYPE TA
A2C39	0160-2265	1	C:FXD CER 22 PF 5% 500VDCW	72982	301-NPO-22PF
A2C40	0180-0229		C:FXD ELECT 33 UF 10% 10VDCW	28480	0180-0229
A2C41	0160-2917		C:FXD CER 0.05 UF +80-20% 100VDCW	84411	TYPE TA
A2C42	0180-0106	2	C:FXD ELECT 60 UF 20% 6VDCW	28480	0180-0106
A2C43	0180-0197		C:FXD ELECT 2.2 UF 10% 20VDCW	56289	150D225X9020A2-DYS
A2C44	0180-0291	1	C:FXD ELECT 1.0 UF 10% 35VDCW	56289	150D105X9035A2-DYS
A2C45	0180-0106		C:FXD ELECT 60 UF 20% 6VDCW	28480	0180-0106
A2C46	0150-0059	1	C:FXD CER 3.3-0.25 PF 500VDCW	72982	301-000-COJ0-339C
A2C47	0160-2930		C:FXD CER 0.01 UF +80-20% 100VDCW	91418	TA
A2C48			NOT ASSIGNED		
A2C49	0180-0197		C:FXD ELECT 2.2 UF 10% 20VDCW	56289	150D225X9020A2-DYS
A2CR1	1901-0026	5	DIODE:SILICON 0.75A 200PIV	04713	SR1358-8
A2CR2	1901-0026		DIODE:SILICON 0.75A 200PIV	04713	SR1358-8
A2CR3	1901-0026		DIODE:SILICON 0.75A 200PIV	04713	SR1358-8
A2CR4	1901-0026		DIODE:SILICON 0.75A 200PIV	04713	SR1358-8
A2CR5			NOT ASSIGNED		
A2CR6	1902-0033	1	DIODE:BREAKDOWN 6.2V	04713	1N823
A2CR7	1901-0040	9	DIODE:SILICON 30MA 30WV	07263	FDG1088
A2CR8	1901-0026		DIODE:SILICON 0.75A 200PIV	04713	SR1358-8
A2CR9			NOT ASSIGNED		
A2CR10			NOT ASSIGNED		
A2CR11	1901-0040		DIODE:SILICON 30MA 30WV	07263	FDG1088
A2CR12	1901-0040		DIODE:SILICON 30MA 30WV	07263	FDG1088
A2CR13	1901-0040		DIODE:SILICON 30MA 30WV	07263	FDG1088
A2CR14	1901-0040		DIODE:SILICON 30MA 30WV	07263	FDG1088
A2CR15	1901-0040		DIODE:SILICON 30MA 30WV	07263	FDG1088
A2CR16	1901-0040		DIODE:SILICON 30MA 30WV	07263	FDG1088
A2CR17	1901-0040		DIODE:SILICON 30MA 30WV	07263	FDG1088
A2CR18	1901-0040		DIODE:SILICON 30MA 30WV	07263	FDG1088
A2Q1	1854-0071	18	TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A2Q2	1854-0062	1	TSTR:SI NPN	80131	2N1701
A2Q3	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A2Q4	1853-0012	1	TSTR:SI PNP	80131	2N2904A
A2Q5	1853-0020	9	TSTR:SI PNP(SELECTED FROM 2N3702)	28480	1853-0020
A2Q6	1853-0020		TSTR:SI PNP(SELECTED FROM 2N3702)	28480	1853-0020
A2Q7	1853-0020		TSTR:SI PNP(SELECTED FROM 2N3702)	28480	1853-0020
A2Q8	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A2Q9	1854-0003	1	TSTR:SI NPN(SELECTED FROM 2N1711)	28480	1854-0003
A2Q10	1853-0001	1	TSTR:SI PNP(SELECTED FROM 2N1132)	28480	1853-0001
A2Q11	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A2Q12			NOT ASSIGNED		
A2Q19			NOT ASSIGNED		
A2Q20	1853-0020		TSTR:SI PNP(SELECTED FROM 2N3702)	28480	1853-0020
A2Q21	1854-0005	3	TSTR:SI NPN	80131	2N708
A2Q22	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A2Q23	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A2Q24	1854-0005		TSTR:SI NPN	80131	2N708
A2Q25			NOT ASSIGNED		

See introduction to this section for ordering information

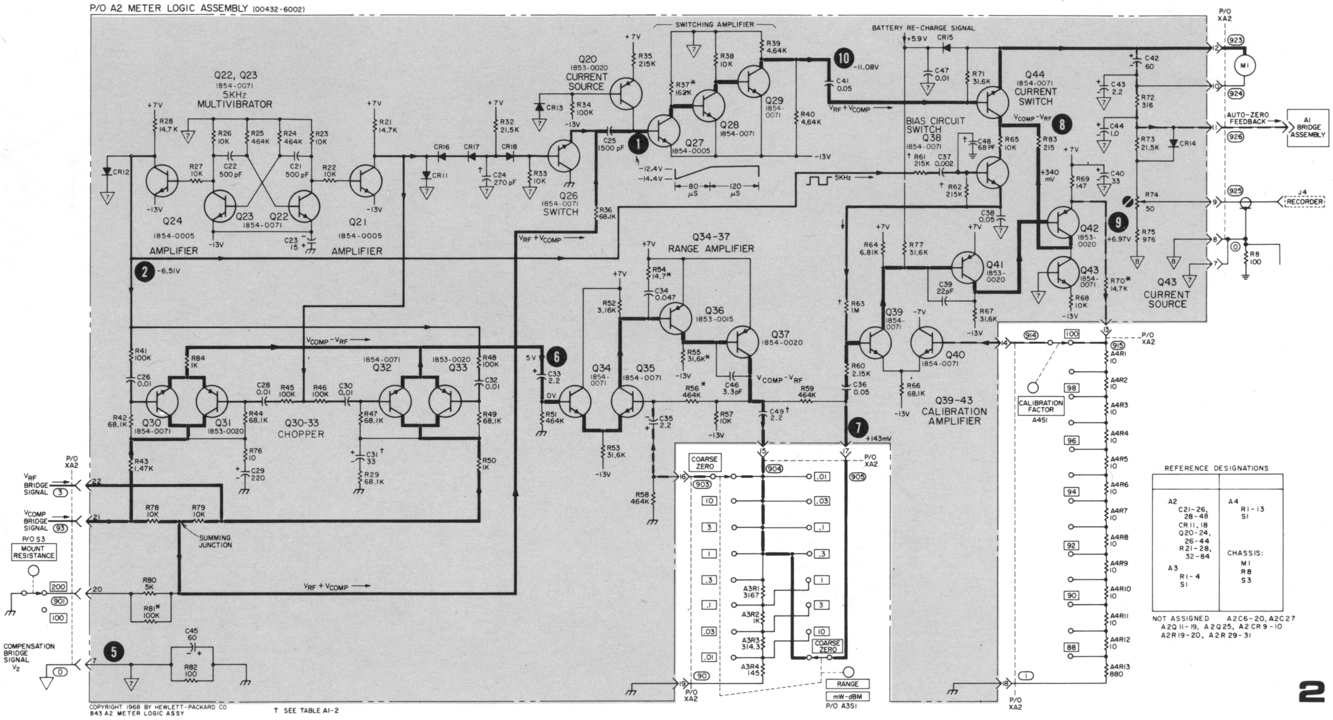
Table AI-3. Back-dating for Table 6-1 (Change C)

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A2Q26	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A2Q27	1854-0005		TSTR:SI NPN	80131	2N708
A2Q28	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A2Q29	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A2Q30	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A2Q31	1853-0020		TSTR:SI PNP(SELECTED FROM 2N3702)	28480	1853-0020
A2Q32	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A2Q33	1853-0020		TSTR:SI PNP(SELECTED FROM 2N3702)	28480	1853-0020
A2Q34	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A2Q35	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A2Q36	1853-0015	1	TSTR:SI PNP	80131	2N3640
A2Q37	1853-0020		TSTR:SI PNP(SELECTED FROM 2N3702)	28480	1853-0020
A2Q38	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A2Q39	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A2Q40	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A2Q41	1853-0020		TSTR:SI PNP(SELECTED FROM 2N3702)	28480	1853-0020
A2Q42	1853-0020		TSTR:SI PNP(SELECTED FROM 2N3702)	28480	1853-0020
A2Q43	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A2Q44	1854-0071		TSTR:SI NPN(SELECTED FROM 2N3704)	28480	1854-0071
A2R1	0757-0279	3	R:FXD MET FLM 3.16K OHM 1% 1/8W	28480	0757-0279
A2R2	0683-0685	1	R:FXD COMP 6.8 OHM 5% 1/4W	01121	CB68G5
A2R3	0757-0835	1	R:FXD MET FLM 6.81K OHM 1% 1/2W	28480	0757-0835
A2R4			NOT ASSIGNED		
A2R5	0698-3156	4	R:FXD MET FLM 14.7K OHM 1% 1/8W	28480	0698-3156
A2R7	0757-0289	1	R:FXD MET FLM 13.3K OHM 1% 1/8W	28480	0757-0289
A2R8	0757-0280	3	R:FXD MET FLM 1K OHM 1% 1/8W	28480	0757-0280
A2R9	0698-3160	6	R:FXD MET FLM 31.6K OHM 1% 1/8W	28480	0698-3160
A2R10	0698-3441	2	R:FXD MET FLM 215 OHM 1% 1/8W	28480	0698-3441
A2R10			FACTORY SELECTED PART		
A2R11	0757-0465	7	R:FXD MET FLM 100K OHM 1% 1/8W	28480	0757-0465
A2R12	0757-0442	11	R:FXD MET FLM 10.0K OHM 1% 1/8W	28480	0757-0442
A2R13	0698-3136	1	R:FXD MET FLM 17.8K OHM 1% 1/8W	28480	0698-3136
A2R14	0757-0346	2	R:FXD MET FLM 10 OHM 1% 1/8W	28480	0757-0346
A2R14			FACTORY SELECTED PART		
A2R15	0757-0442		R:FXD MET FLM 10.0K OHM 1% 1/8W	28480	0757-0442
A2R16	0757-0279		R:FXD MET FLM 3.16K OHM 1% 1/8W	28480	0757-0279
A2R17	0757-0198	1	R:FXD MET FLM 100 OHM 1% 1/2W	28480	0757-0198
A2R19			NOT ASSIGNED		
A2R20			NOT ASSIGNED		
A2R21	0698-3156		R:FXD MET FLM 14.7K OHM 1% 1/8W	28480	0698-3156
A2R22	0757-0442		R:FXD MET FLM 10.0K OHM 1% 1/8W	28480	0757-0442
A2R23	0757-0442		R:FXD MET FLM 10.0K OHM 1% 1/8W	28480	0757-0442
A2R24	0698-3260	9	R:FXD MET FLM 464K OHM 1% 1/8W	28480	0698-3260
A2R25	0698-3260		R:FXD MET FLM 464K OHM 1% 1/8W	28480	0698-3260
A2R26	0757-0442		R:FXD MET FLM 10.0K OHM 1% 1/8W	28480	0757-0442
A2R27	0757-0442		R:FXD MET FLM 10.0K OHM 1% 1/8W	28480	0757-0442
A2R28	0698-3156		R:FXD MET FLM 14.7K OHM 1% 1/8W	28480	0698-3156
A2R29			NOT ASSIGNED		
A2R31			NOT ASSIGNED		
A2R32	0757-0199	2	R:FXD MET FLM 21.5K OHM 1% 1/8W	28480	0757-0199
A2R33	0757-0442		R:FXD MET FLM 10.0K OHM 1% 1/8W	28480	0757-0442
A2R34	0757-0465		R:FXD MET FLM 100K OHM 1% 1/8W	28480	0757-0465
A2R35	0698-3454	1	R:FXD MET FLM 215K OHM 1% 1/8W	28480	0698-3454
A2R36	0757-0461	6	R:FXD MET FLM 68.1K OHM 1% 1/8W	28480	0757-0461
A2R37	0757-0470	1	R:FXD MET FLM 162K OHM 1% 1/8W	28480	0757-0470
A2R38	0757-0442		R:FXD MET FLM 10.0K OHM 1% 1/8W	28480	0757-0442
A2R39	0698-3155	2	R:FXD MET FLM 4.64K OHM 1% 1/8W	28480	0698-3155
A2R40	0698-3155		R:FXD MET FLM 4.64K OHM 1% 1/8W	28480	0698-3155
A2R41	0757-0465		R:FXD MET FLM 100K OHM 1% 1/8W	28480	0757-0465
A2R42	0757-0461		R:FXD MET FLM 68.1K OHM 1% 1/8W	28480	0757-0461
A2R43	0757-1094	1	R:FXD MET FLM 1.47K OHM 1% 1/8W	28480	0757-1094
A2R44	0757-0461		R:FXD MET FLM 68.1K OHM 1% 1/8W	28480	0757-0461
A2R45	0757-0465		R:FXD MET FLM 100K OHM 1% 1/8W	28480	0757-0465
A2R46	0757-0465		R:FXD MET FLM 100K OHM 1% 1/8W	28480	0757-0465
A2R47	0757-0461		R:FXD MET FLM 68.1K OHM 1% 1/8W	28480	0757-0461
A2R48	0757-0465		R:FXD MET FLM 100K OHM 1% 1/8W	28480	0757-0465
A2R49	0757-0461		R:FXD MET FLM 68.1K OHM 1% 1/8W	28480	0757-0461
A2R50	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	28480	0757-0280
A2R51	0698-3260		R:FXD MET FLM 464K OHM 1% 1/8W	28480	0698-3260
A2R52	0757-0279		R:FXD MET FLM 3.16K OHM 1% 1/8W	28480	0757-0279
A2R53	0698-3160		R:FXD MET FLM 31.6K OHM 1% 1/8W	28480	0698-3160
A2R54	0698-3428	1	R:FXD MET FLM 14.7 OHM 1% 1/8W	28480	0698-3428
A2R54			FACTORY SELECTED PART		
A2R55	0698-3160		R:FXD MET FLM 31.6K OHM 1% 1/8W	28480	0698-3160
A2R55			FACTORY SELECTED PART		

Table AI-3. Back-dating for Table 6-1 (Change C)

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A2R56	0698-3260		R:FXD MET FLM 464K OHM 1% 1/8W	28480	0698-3260
A2R57	0757-0442		R:FXD MET FLM 10.0K OHM 1% 1/8W	28480	0757-0442
A2R58	0698-3260		R:FXD MET FLM 464K OHM 1% 1/8W	28480	0698-3260
A2R59	0698-3260		R:FXD MET FLM 464K OHM 1% 1/8W	28480	0698-3260
A2R60	0698-0084	1	R:FXD MET FLM 2.15K OHM 1% 1/8W	28480	0698-0084
A2R61	0698-3260		R:FXD MET FLM 464K OHM 1% 1/8W	28480	0698-3260
A2R62	0698-3260		R:FXD MET FLM 464K OHM 1% 1/8W	28480	0698-3260
A2R63	0698-3260		R:FXD MET FLM 464K OHM 1% 1/8W	28480	0698-3260
A2R64	0757-0439	1	R:FXD MET FLM 6.81K OHM 1% 1/8W	28480	0757-0439
A2R65	0757-0442		R:FXD MET FLM 10.0K OHM 1% 1/8W	28480	0757-0442
A2R66	0757-0461		R:FXD MET FLM 68.1K OHM 1% 1/8W	28480	0757-0461
A2R67	0698-3160		R:FXD MET FLM 31.6K OHM 1% 1/8W	28480	0698-3160
A2R68	0757-0442		R:FXD MET FLM 10.0K OHM 1% 1/8W	28480	0757-0442
A2R69	0698-3438	1	R:FXD MET FLM 147 OHM 1% 1/8W	28480	0698-3438
A2R70	0698-3156		R:FXD MET FLM 14.7K OHM 1% 1/8W	28480	0698-3156
A2R71	0698-3160		R:FXD MET FLM 31.6K OHM 1% 1/8W	28480	0698-3160
A2R72	0698-3444	1	R:FXD MET FLM 316 OHM 1% 1/8W	28480	0698-3444
A2R73	0757-0199		R:FXD MET FLM 21.5K OHM 1% 1/8W	28480	0757-0199
A2R74	2100-1769	1	R:VAR WW 50 OHM 5% TYPE H 1W	28480	2100-1769
A2R75	0698-4466	1	R:FXD MET FLM 976 OHM 1% 1/8W	28480	0698-4466
A2R76	0757-0346		R:FXD MET FLM 10 OHM 1% 1/8W	28480	0757-0346
A2R77	0698-3160		R:FXD MET FLM 31.6K OHM 1% 1/8W	28480	0698-3160
A2R78	0811-2277	2	R:FXD WW 10K OHM 0.1% 1/40W	28480	0811-2277
A2R79	0811-2277		R:FXD WW 10K OHM 0.1% 1/40W	28480	0811-2277
A2R80	0811-2537	1	R:FXD WW 5K OHM 0.1% 1/40W	28480	0811-2537
A2R81	0757-0465		R:FXD MET FLM 100K OHM 1% 1/8W	28480	0757-0465
A2R81			FACTORY SELECTED PART		
A2R82	0757-0401	1	R:FXD MET FLM 100 OHM 1% 1/8W	28480	0757-0401
A2R83	0698-3441		R:FXD MET FLM 215 OHM 1% 1/8W	28480	0698-3441
A2R84	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	28480	0757-0280
	0360-0124	1	TERMINAL:SOLDER LUG	28480	0360-0124

See introduction to this section for ordering information


P/O A2 METER LOGIC ASSEMBLY (00432-6002)
Q22, Q23
1854-0071
5KHz
MULTIVIBRATOR
Q24
1854-0005
AMPLIFIER
Q23 Q22
1854-0071
Q21
1854-0005
AMPLIFIER
Q20
1853-0020
CURRENT
SOURCE
Q26
1854-0071
SWITCH
SWITCHING AMPLIFIER
Q27
1854-0005
Q28
1854-0071
Q29
1854
0071
-11.08V
VRF + VCOMP
BATTERY RE-CHARGE SIGNAL
+5.9V
Q44
1854-0071
CURRENT
SWITCH
BIAS CIRCUIT
SWITCH
Q38
1854-0071
VCOMP - VRF
5KHz
+340 mV
Q42
1853-0020
Q43
1854-0071
+6.97V
Q41
1853-0020
Q43
CURRENT
SOURCE
-6.51V
Q34-37
RANGE AMPLIFIER
Q36
1853-0015
Q37
1854-0020
Q34
1854-0071
Q35
1854-0071
VCOMP - VRF
Q39
1854-0071
Q40
1854-0071
Q39-43
CALIBRATION
AMPLIFIER
+143mV
Q30
1854-0071
Q31
1853-0020
Q30-33
CHOPPER
Q32
1854-0071
Q33
1853-0020
5V
0V
-12.4V
-14.4V
80 µS
120 µS
VRF BRIDGE SIGNAL
VCOMP BRIDGE SIGNAL
P/O S3
MOUNT RESISTANCE
SUMMING JUNCTION
COMPENSATION BRIDGE SIGNAL V2
P/O XA2
COARSE ZERO
RANGE
mW-dBM
P/O A3S1
CALIBRATION FACTOR
A4S1
M1
AUTO-ZERO FEEDBACK
A1 BRIDGE ASSEMBLY
J4
RECORDER
REFERENCE DESIGNATIONS
A2 C21-26, 28-48 CR11, 18 Q20-24, 26-44 R21-28, 32-84
A3 R1-4 S1
A4 R1-13 S1
CHASSIS: M1 R8 S3
NOT ASSIGNED A2C6-20, A2C27 A2Q11-19, A2Q25, A2CR9-10 A2R19-20, A2R29-31
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843 A2 METER LOGIC ASSY
† SEE TABLE AI-2
2

Figure AI-1. Meter Logic Schematic

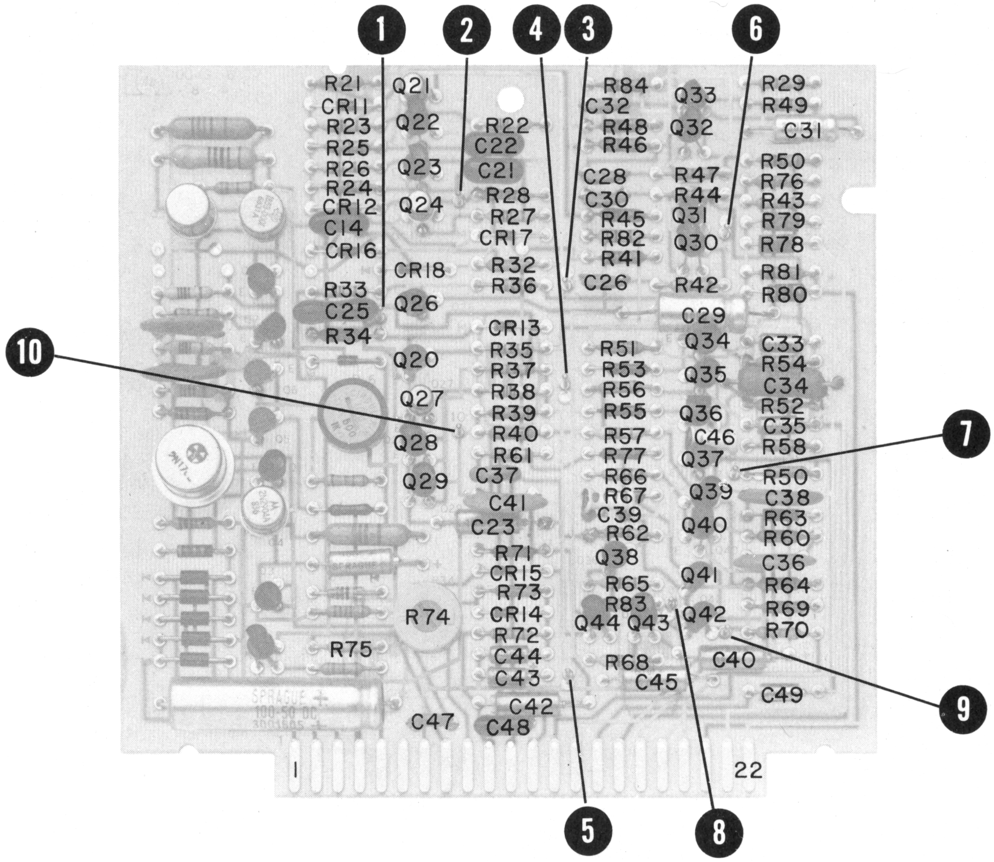
1
2
4
3
6
R21
CR11
R23
R25
R26
R24
CR12
C14
CR16
R33
C25
R34
Q21
Q22
Q23
Q24
CR18
Q26
Q20
Q27
Q28
Q29
R22
C22
C21
R28
R27
CR17
R32
R36
CR13
R35
R37
R38
R39
R40
R61
C37
C41
C23
R71
CR15
R73
CR14
R72
C44
C43
C42
C48
C47
R74
R75
R84
C32
R48
R46
C28
C30
R45
R82
R41
C26
R51
R53
R56
R55
R57
R77
R66
R67
C39
R62
Q38
R65
R83
Q44
Q43
R68
C45
Q33
Q32
R47
R44
Q31
Q30
R42
C29
Q34
Q35
Q36
C46
Q37
Q39
Q40
Q41
Q42
C40
R29
R49
C31
R50
R76
R43
R79
R78
R81
R80
C33
R54
C34
R52
C35
R58
R50
C38
R63
R60
C36
R64
R69
R70
C49
10
7
9
1
22
5
8

Figure AI-2. A2 Meter Logic Assembly Component Locations Back-Dating (Change C)

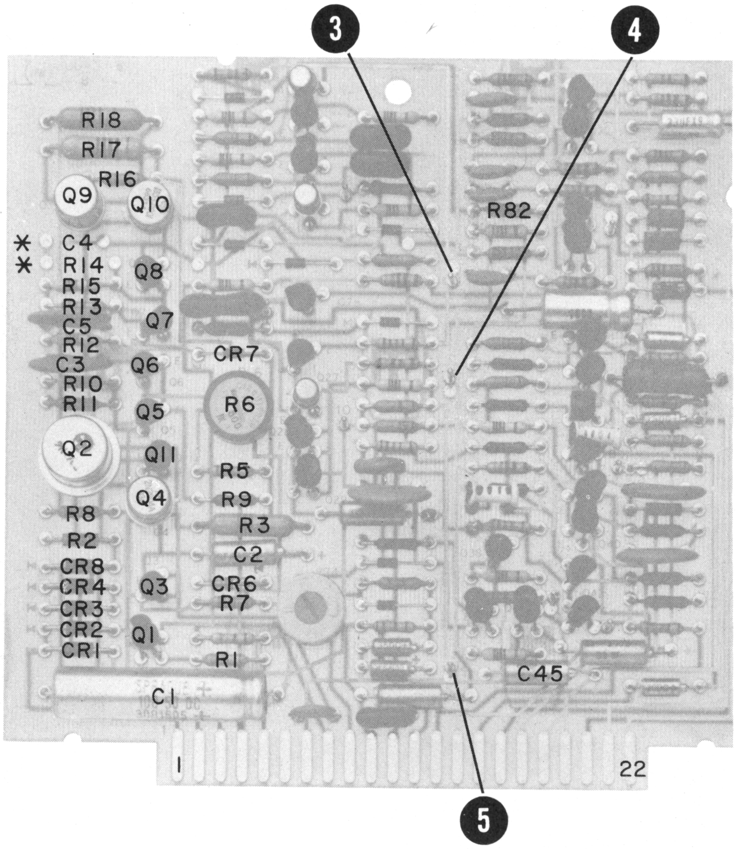
3
4
R18
R17
R16
Q9
Q10
*
C4
*
R14
R15
R13
C5
R12
C3
R10
R11
Q8
Q7
Q6
Q5
CR7
R6
Q2
Q11
Q4
R5
R9
R3
C2
R8
R2
CR8
CR4
CR3
CR2
CR1
Q3
Q1
CR6
R7
R1
C1
R82
C45
1
22
5

Figure AI-3. A2 Meter Logic Assembly, Power Supply Component Locations Back-Dating (Change C)

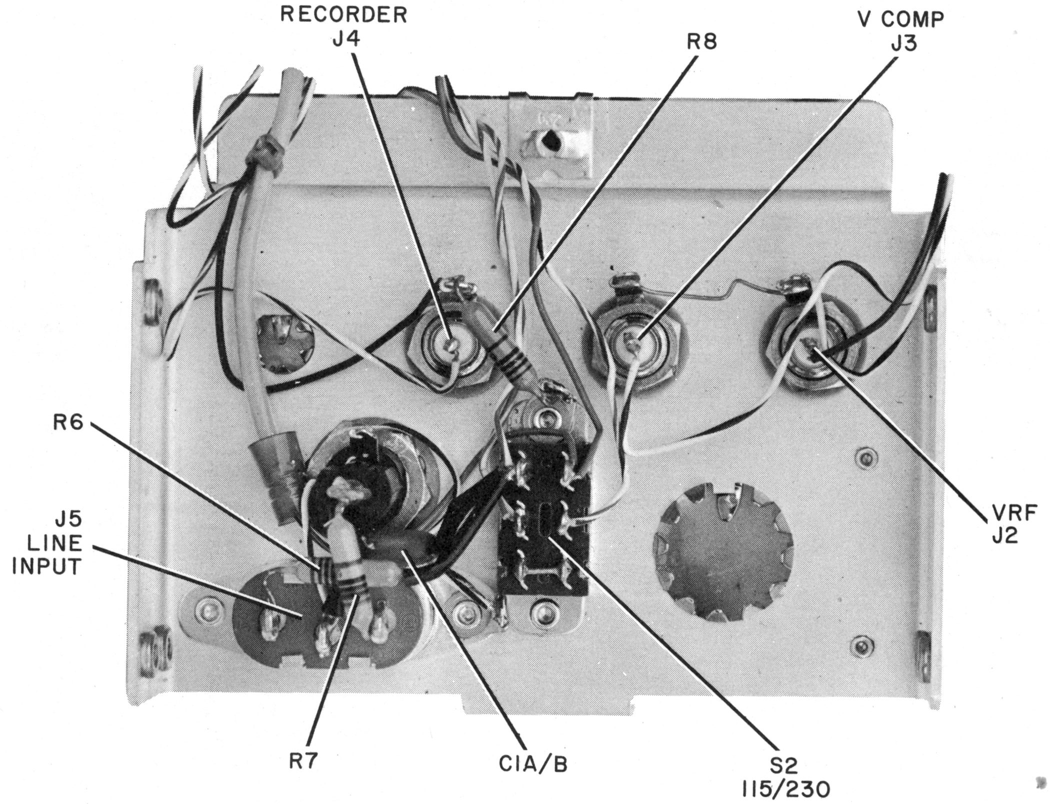
RECORDER
J4
R8
V COMP
J3
R6
J5
LINE
INPUT
VRF
J2
R7
CIA/B
S2
115/230

Figure AI-4. 432A Rear Panel Interior Back-Dating (Change G)

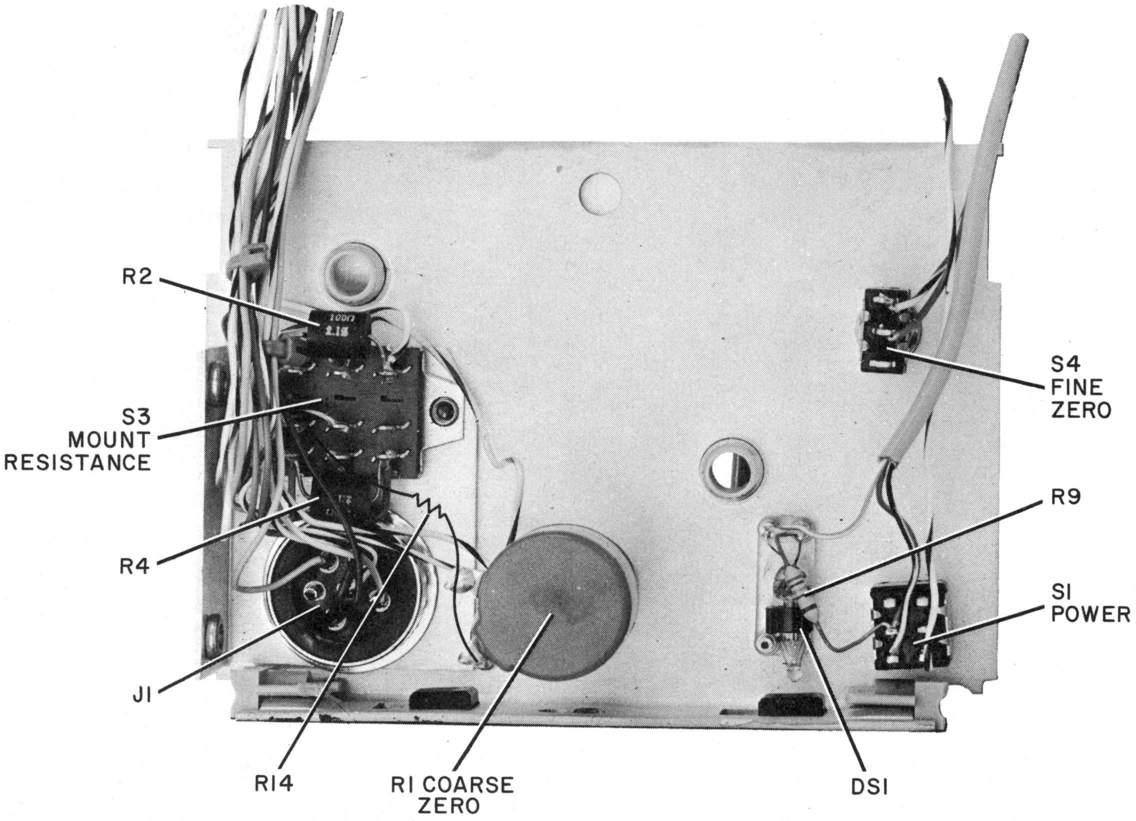
R2
S3
MOUNT
RESISTANCE
R4
J1
R14
R1 COARSE
ZERO
DS1
S4
FINE
ZERO
R9
S1
POWER

Figure AI-5. 432A Front Panel Interior Back-Dating (Change I)

APPENDIX II

INSTALLATION OF LONG CABLE OPTIONS

AII-1. Information in this appendix describes installation of the long cable options used with the 432A Power Meters. Table AII-1 lists the options, cable length and stock numbers. After completion of the installation procedures, the power meter should be recalibrated using the procedures in Section V of this manual.

NOTE

> These cable option kits are for mount resistances of either 100 or 200 ohms.

AII-2. Depending on the option selected, the following components are added or replaced with parts supplied with the option kits:

a. C2

b. R10, R11, R12 and R13

c. A1R32 and A1R42

d. A2C45

AII-3. The following equipment is required for the installation of the long cable options:

a. Soldering Tool, wattage rating: 37.5

b. De-soldering aid

c. Pozidriv screwdriver (small)

d. Pozidriv screwdriver (medium)

Table AII-1. 432A Power Meter Long Cable Options

Option	Kit Number	Cable Length (feet)
009	00432-6018	10
010	00432-6019	20
011	00432-6020	50
012	00432-6021	100
013	00432-6022	200

AII-4. No substitution can be made for long cables listed in Table AII-1. Long cables from the older power meters, such as the 431 series, cannot be interchanged with 432A long thermistor cables because of resistance variations.

AII-5. If a long cable option of 20-feet or longer is used with a *balanced* thermistor mount such as the HP 8478B, pins 2 and 4 must be shorted at the mount end of the cable. This short can be accomplished with an 11527A Adapter available from Hewlett-Packard. The 11527A, connected between the mount and the cable, can be removed for instrument operation with an unbalanced mount.

NOTE

> If a 432A has been modified for a particular cable option, it is incompatible with all other cable lengths.

AII-6. The parts required for the modification are listed in Table 6-1 and shown on the appropriate Service Sheet.

AII-7. OPTION 009 INSTALLATION.

AII-8. Option 009 (10-foot cable) requires no modification to the 432A Power Meter. The longer cable is substituted for the standard five-foot thermistor cable.

AII-9. OPTION 010 INSTALLATION.

a. Remove the right side and top covers from the 432A. Remove the A1 Bridge Assembly circuit board from the instrument.

b. Referring to Figure 7-7, locate the board position where A1R42 is to be placed. Install the 261K, 1%, 0.125W resistor, supplied with the kit, in that position.

c. Place the modification decal on the top center of the front panel.

d. This completes the Option 010 installation. Before replacing the top and side panels, connect the ten-foot cable and perform the bridge amplifier adjustments in Section V of this manual.

AII-10. OPTION 011 THROUGH 013 INSTALLATION.

a. Remove both side, top and bottom covers. Remove the A1 Bridge Assembly.

b. Locate the printed circuit board eyelets in which A1R32 and A1R42 are to be placed by referring to Figure 7-7. Note that one end of these resistors will be placed inside the guard rings that attach to the bases of A1Q12B and A1Q7B. There is a vacant eyelet provided inside the guard rings to make this connection.

c. Install the correct value A1R32 and A1R42 for the desired option.

d. Place the 432A on its top; Figure 7-5 reveals the location of bridge resistors R3 and R5 on terminal strip XA1. Select the proper values of resistors R10 and R11 from the option kit. Solder R11 across pins 3 and 5 of XA1 in parallel with R5 and solder R10 across pins 6 and 8 of XA1 in parallel with R3.

e. Locate the MOUNT RESISTANCE switch S3 on the back of the front panel. Bridge resistors R2 and R4 are wired to the rear of S3 (see Figure 7-6). Choose the resistors supplied with the option kit for R12 and R13. Solder R12 across R2 and R13 across R4.

f. Capacitor C2 (2.2 μF) is connected across the rear of the FINE ZERO switch S4 (see Figure 7-6). With the instrument resting on its top, wire the positive lead of C2 to the terminal of S4 with the white/black/violet (907) wire and the negative lead to the terminal with the violet (7) wire.

g. Remove the A2 Meter Logic Board. A2C45 by referring to Figure 7-11.

Remove the 60 μF capacitor and replace it with the 300 μF capacitor supplied with the option kit. Observe the polarity as marked on the circuit board.

h. Place the modification decal on the top center of the front panel.

i. This completes the modification. Install the A1 and A2 boards back in the instrument. Perform the adjustment procedures in Section V of this manual with the long cable.

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